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## REPAIR OF NERVES AND TENDONS OF THE HAND*

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### INTRODUCTION

There are throughout the world, and largely resulting from industrial injuries, myriads of crippled hands in need of repair. From a social standpoint the functioning of this valued member is of vital importance to the manual worker for his very livelihood.

The human hand is one of the higher evolutionary developments of our biped existence, which is largely responsible for the great handicraft of man. Although it is composed mainly of tough material, it also includes exact machinery of much refinement and tissues of great delicacy and specialization. Such a mechanism is readily wrecked by trauma and infection and it is little wonder that hands mangled by trauma, or those infiltrated and gutted by infection, later present difficult problems in reconstruction.

The hands that come for repair range from those with but a simple severance of a nerve or tendon to those with extensive crippling, in which all of the structures have been damaged. The ravages of infection have left the tissues solidly congealed by cicatricial tissue, joints have stiffened in non-functionating positions, flexion contractures are present and great lengths of tendons and nerves may have sloughed and been reduced to scar tissue. Thus our repairs are usually not limited to nerves and tendons, but must include all the tissues.

### REPAIR OF NERVES[1,2]

The two major functions of the hand are sensation and motion and these are of equal importance. If the nerves in the hand are severed, a manual worker is greatly crippled, especially if in the special tactile area of the distribution of the median nerve. The eyes of his fingers are blind and

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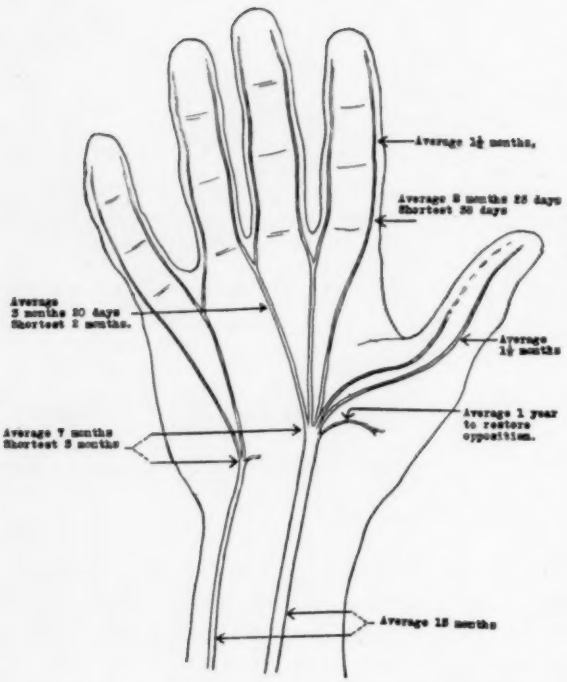


FIG. 1

(By courtesy of *Surgery, Gynecology and Obstetrics.*)

Diagram showing in this series the average and the shortest time taken after suturing nerves, where indicated by arrows, to restore sensation to cotton wool and pin prick over the entire area formerly anaesthetic, including the finger tips.

even his joint sense is gone. Trophic disturbance reduces his fingers to insensitive hooks. He is awkward and fumbles and cannot find, distinguish or hold objects and frequently burns or injures his fingers. Loss of the motor fibers of the median nerve usually robs him of the power to oppose his thumb to his fingers and the loss of the motor branch of the ulnar nerve results in a claw-hand, weak thumb and absence of the finer movements of the fingers. Thus, severance of the nerves of the hand may cripple a worker to any degree. Fortunately, however, most of the function can usually be restored to him by repairing these nerves.

Suture of the nerves in the hand or fingers is not difficult and the results are more satisfactory than after any other nerve suture. This is probably because they are no longer mixed nerves, and due to the fact that in the nervous system the nearer the repair is to the periphery the better is the regeneration. In repairing 131 nerves, seventy-six of which were in the hand and fifty-five in the fingers, the results have been so unusually and uniformly satisfactory that it is the more wonder that the author has been unable to find in the literature mention of suture of nerves below the wrist. The nerves are large enough for end to end suture even as far as opposite the distal crease in a finger. The finest silk on No. 16 straight Kirby needles is used (obtainable threaded in ampules for use in suturing blood-vessels). Using two guide sutures, six sutures in all are placed, each including the sheath only. The apposition must be accurate. If a main nerve is to be joined to its several branches, as the median to its six branches in the palm, one central stitch first catches together the sheaths of the various branches, tying them into one, and the rest of the suturing is done in the usual manner. My series includes the motor branch of the ulnar, the dorsal

branch of the ulnar, the radial nerve in the hand, palmar and volar nerves, and in three instances the thenar motor branch of the thumb. The latter were followed by restoration of opposition of the thumb in eleven, twelve, and thirteen months, respectively.

After nerve suture, sensation in the order of heavy touch, then pin prick and light touch, is restored progressively down the hand and fingers at the average rate of the length of a finger segment a month. It reaches the degree of stereognosis in an average of twelve months after nerve suture in a finger and sixteen months after suturing in the palm. The speed of regeneration is not influenced by how long the nerve has been severed, judging from my series, in which most repairs were made in the first year and some as long as four years after injury. Age showed a moderate influence, in that the cases of slow, medium and rapid regeneration averaged thirty-one, twenty-five, and twenty-one years of age, respectively, although some older people showed rapid regeneration and some younger ones slower. The factor of greatest influence of all was the state of nutrition of the hand. If a previous storm of infection had caused poor nutrition by leaving the nerves, lymphatics and blood-vessels strangled by cicatrix, the regeneration of the nerves was slower and not so complete.

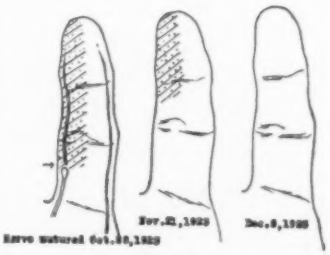

FIG. 2

(By courtesy of *Surgery, Gynecology and Obstetrics.*)

J. C., age 21. Four months previously the volar nerve on the ulnar side of the index finger was severed with a knife. The nerve was sutured on Oct. 28, 1923. The area insensitive to cotton wool (shaded) and pin prick (dotted) receded, as shown by dates on diagrams.

Gaps between the nerve ends, some even to three inches, can be overcome by freeing the nerves for a distance and by flexing the fingers, and if necessary the wrist, elbow and shoulder, followed by gradual extension after a month. In the case of the ulnar nerve, length may be gained by transplanting it to the front of the elbow. If the gaps are greater, free nerve grafts can be taken from the sural nerve in the leg. In my six cases in which nerve grafts were used, some of which were six inches long, the regeneration, contrary to a prevalent belief, was almost as rapid and complete as after simple nerve suture and reached even to the degree of stereognosis, such as distinguishing the articles in one's pocket.

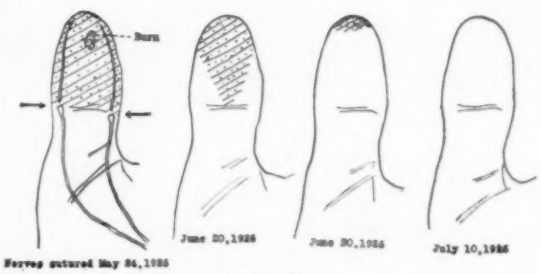


FIG. 3

(By courtesy of *Surgery, Gynecology and Obstetrics.*)

J. L., age 28. Three months previously both volar nerves of the thumb were cut with a knife rendering the pulp of the thumb anaesthetic and interfering with his work. The nerves were sutured on May 24, 1926, and the anaesthesia to cotton wool (shaded) and analgesia to pin prick (dotted) receded, as shown by the dates on the diagrams.

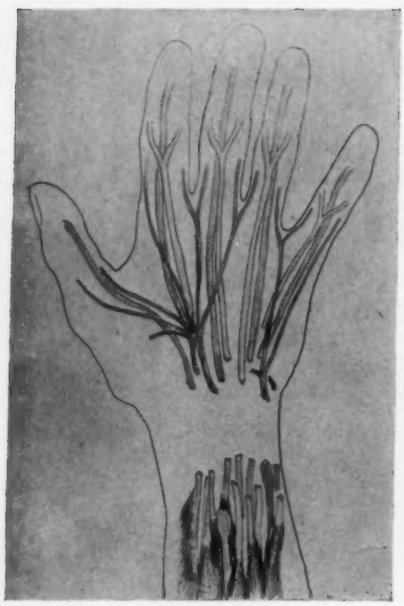

FIG. 4-A

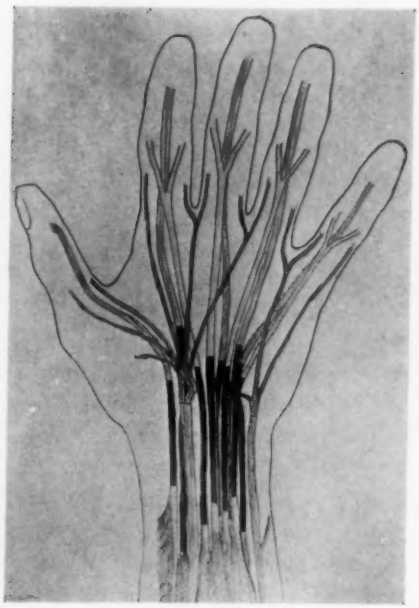

FIG. 4-B

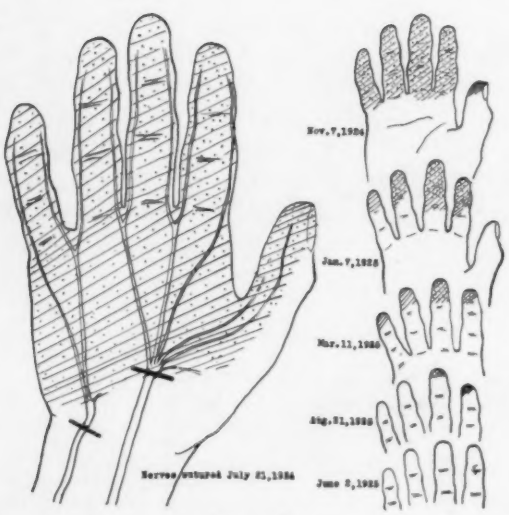


FIG. 4-C
(By courtesy of *Surgery, Gynecology and Obstetrics.*)

A. L., age 54. Five months previously a forest bit entered the front of the wrist. This and the infection that followed destroyed all of the tendons and nerves in the front of the wrist. The ends of the ulnar nerve were separated by an inch and the median by three inches. Nutrition of the hand was poor. On July 21, 1924, the two nerves were sutured where indicated, and nine tendon grafts from the extensors of the toes were used to bridge the tendons, as shown in *A*, *B* and *C*.

Anaesthesia to cotton wool (shaded) and analgesia to pin prick (dotted) receded, as shown by the dates on the diagrams. The power of opposition returned to the thumb, as it does in about sixty per cent. of cases of repair by suture of the median nerve. Enough movement returned in the fingers and thumb to allow the hand to open about three inches and to grasp firmly.

## FREE TENDON GRAFTS*

In restoring tendons in late cases of crippled hands it is for the following reasons usually not possible to merely join by suture the two ends of a tendon. It will be found that the muscle is so contracted that the ends of the tendon cannot be approximated at normal tension. In other cases great lengths of tendon will have sloughed away or will have been reduced to scar, while in others the tendon remaining will be yellowish and brittle from the degeneration of non-use, as tendons like bones need function to thrive.

FIG. 5-A

FIG. 5-B
(By courtesy of *Surgery, Gynecology and Obstetrics.*)

FIG. 5-C

FIG. 5-D

C. J. J. An infection five months previously in the sheath of the flexor tendons of the ring finger, which was drained through a median longitudinal incision in the base of the finger, resulted in loss of the flexor tendons and in the scar contracture of the finger which limits the extension, as shown in *A*.

Operation: The scar was removed from the volar surface of the finger together with the remains of the flexor tendons, the finger was straightened on a splint, and the denuded area was covered by a skin graft from the tubular pedicle in the pectoral region shown in *A*. Four months after good skin was supplied, a new flexor tendon was transplanted into the finger from the flexor sublimus of the same digit, which was removed from the forearm. In the palm it was sutured to the tendon of the flexor profundus, and distally it was fastened through a drill-hole in the distal phalanx to the insertion of the extensor tendon, as shown in *B*. *C* and *D* taken three months later show the result.

*Further details and photographs of results are given in papers listed in the bibliography.

We, therefore, must resort in the majority of tendon repairs to free tendon grafts to bridge our tendon deficiencies.

In operating on 583 tendons in the hand and forearm the procedures adopted were in order of their frequency: First, free tendon grafting; second, freeing the tendon from scar tissue, usually by excising the cicatrix; third, end to end suture of tendon; lastly, tendon transference.

The grafts were usually taken from the palmaris longus, the flexor sublimus of the same finger and the long extensors of the toes. Many times I have at later dates uncovered these grafts and seen that, although they swell somewhat in the first three weeks, and become adherent to surrounding tissues, still eventually they have the gross appearance and strength of the normal tendon and free themselves enough from adhesions to give good function. After an experience with 259 of these free grafts over a period of fourteen years I have no longer any hesitation or doubt in using them.

Whenever a tendon in a finger or hand is found to be rough, cicatricial and grossly adherent, it is better to remove it and replace it with a new one. If the flexor tendons are severed in a finger in the usual place opposite the proximal phalanx, one cannot join them by suture with success, as the junction will become adherent in the narrow fixed channel and will not slip. It is better to remove the tendons entirely from the finger and graft in a new tendon smooth throughout its length. The suturing is then done in the palm and at the distal phalanx where adhesions will be of less importance. One flexor tendon in a finger must suffice, for if in our repair we allow two to remain they will become adherent to each other, and thus act on the middle joint only and not on the distal one.

FIG. 6-A

FIG. 6-B

C. M. S. Six months previously the two short extensor tendons of the thumb and the radial nerve were severed by a knife. Considerable disability of the hand resulted, in that the thenar eminence rode forward. Abduction of the thumb was limited one-half inch and the thumb lost much of its function. He grasped either without the thumb or on the dorsal surface of the flexed thumb. The pinch of the thumb was weak, in that the arch of the thumb was gone. As the metacarpal lacked extension, the metacarpophalangeal joint dropped forward in pinching. This shows the fallacy of using the extensor brevis pollicis tendon in operations to gain opposition for the thumb.

The radial nerve was sutured and as the muscles had retracted a two-inch tendon graft from the palmaris longus, plus its paratenon, was used to bridge each of the short extensor tendons of the thumb.

In three months sensation returned and he had normal function of the thumb, as shown in *B*.

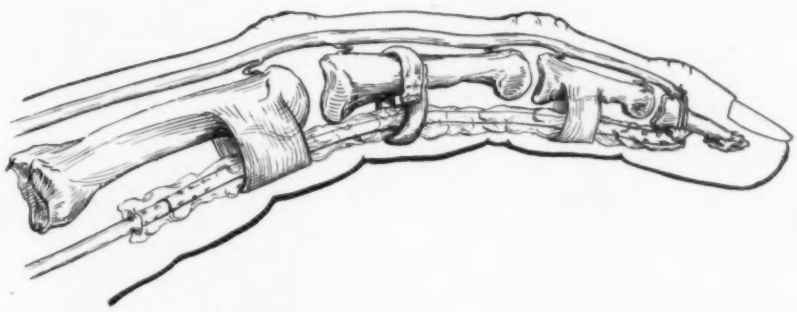

FIG. 7

Diagram of reconstruction of a tendon in a finger. A free graft of tendon plus its paratenon has been threaded through the three pulleys (two natural and one reconstructed).

The graft is sutured to the profundus in the palm and to the distal phalanx where adhesions will do the least harm. The distal phalanx is first scraped for bony contact. The two sutures pass through a drill-hole in the distal phalanx and are secured through the insertion of the extensor tendon. The extensor tendon forms the posterior part of the capsules of the joints.

## THE GLIDING MECHANISM

Whenever the bed of a tendon or tendon graft is of firm cicatricial tissue and is without a tendon sheath or a surrounding soft paratenon, it is necessary, in order to obtain motion, to graft a sliding mechanism about the tendon. For this the paratenon is grafted with the tendon as a whole sliding mechanism intact, or else paratenon fat, preferably from over the triceps tendon, is grafted as a sleeve about the tendon, or is folded about as a wide sheet to separate many tendons. Paratenon is the specialized elastic fat which is found about a tendon in the straight part of its course. This formation is distinguished from the tendon sheath formation found where a tendon rounds a corner. Paratenon fat differs much from the short-fibered, tough subcutaneous fat. A thin layer is also obtainable from over the fascia lata and tendons with paratenon attached are available from the long extensors of the toes (the brevis will serve to elevate the toes) and from the palmaris longus. Small plaques may also be used to interpose between a tendon and exposed scar tissue or bone.

In a finger the tissues are often sufficiently soft and free from cicatrix to allow us to use as a graft the tendon of the sublimus muscle of the same finger. Such a tendon has about it a thin transparent layer of paratenon which will allow considerable motion. If the tendon bed be more cicatricial it is better to graft a tendon with thicker paratenon or to add more paratenon.

It is not practical to transplant a tendon plus its tendon sheath, although sheath material can be transplanted from the olecranon or other bursa.

FIG. 8-A

FIG. 8-B

(By courtesy of *Surgery, Gynecology and Obstetrics.*)

Miss S. P. Six months previously a laceration in the index finger resulted in tenosynovitis and an abscess in the thenar space. The latter was drained through an incision in the palm at the base of the thenar eminence. As the thenar branch of the median was severed the opponens pollicis and abductor pollicis muscles were paralyzed and had become atrophied, so the thumb could no longer oppose the fingers.

On Aug. 4, 1924, this tiny nerve was sutured where shown in the diagram, with full recovery of the power of opposition thirteen months later. The photograph shows that the thenar muscles are functionating well and that their atrophy has gone.

FIG. 9-A FIG. 9-B

M. V. Showing the result of the pulley operation for opposition of the thumb in a case of poliomyelitis where the tissues are free from cicatrix.

In *A* is shown the extreme degree of opposition of the thumb possible before operation, and in *B* is seen the ability postoperatively to oppose the thumb in spite of the atrophy in the abductor and opponens pollicis.

It is apparent then, that in order to make our tendons glide we should imitate as much as possible the natural gliding mechanism of tendons, which has been originally studied and described by Biesalski and Mayer [1 and 3].

## EXCISION OF CICATRIX

On exposing the contents of the forearms and hands crippled by trauma and infection and their resulting tissue reactions, it will be found that all of the structures are bound together by a syncytium of scar tissue. This octopus-like structure not only binds the tendons and contracts all of the tissues into a hard mass, but as the original infection traveled along the natural passageways in the tissues the resulting scar strangles especially the nerves, lymphatics and blood-vessels, thus greatly reducing the nutrition of the hand. The tough cicatrix should be carefully dissected out and excised, as in a block dissection for carcinoma, until only good tissue is left, because scar tissue in healing makes scar tissue. If it is excised, circulation, nerve action and mobility of tissues are improved. If a tendon be merely freed from cicatrix, it will again become adherent.

Where infection has been great the most damage will be found to be in the narrow unyielding ischemia-producing channels under annular ligaments, such as the wrist, base of palm and in the fingers, and here the tendons will be found most frequently to have been replaced by cicatrix. Our aim should be to excise the cicatrix to healthy tissue, to have a minimum number of moving tendons and maximum amount of gliding mechanism. A postoperative cicatrization will follow, but our technique should be so aseptic and so atraumatic that this will be at a minimum.

FIG. 10-A FIG. 10-B FIG. 10-C FIG. 10-D

(By courtesy of *Surgery, Gynecology and Obstetrics.*)

G. T. Showing the advantage of using the pedicle skin graft by the closed or tubular method in order to reduce the amount of keloid or scar tissue in the borders of the graft. The contracture was caused by a burn from a hot stove.

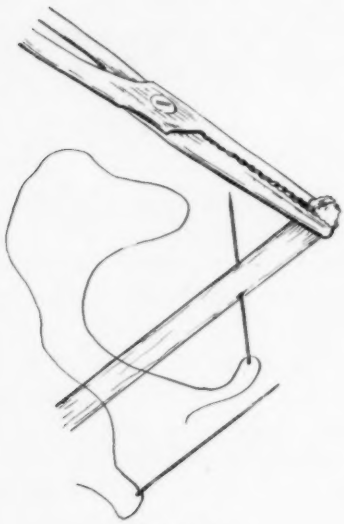

FIG. 11-A

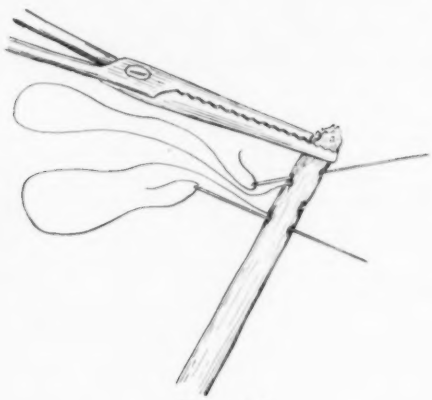

FIG. 11-B

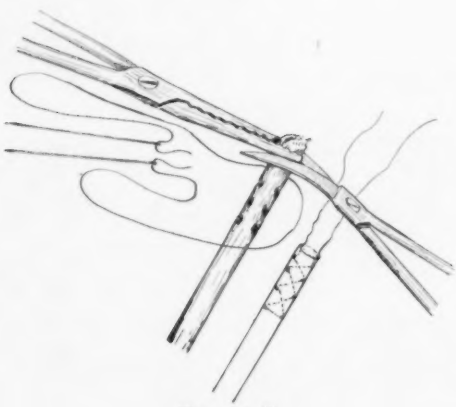

FIG. 11-C

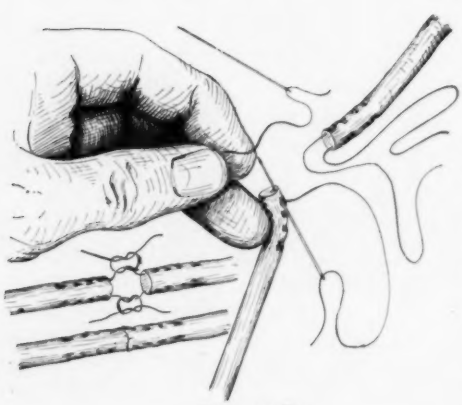

FIG. 11-D

Showing method of uniting tendons end to end. The delicate epitenon is not traumatized.

As shown in *A*, with the tendon held taut by a Kocher hemostat, one of the two needles is passed through it diagonally, starting about a centimeter back. Three similar stitches in all are taken with this needle. At each the needle reenters the tendon a short transverse distance from where it emerged and finally the needle emerges two or three millimeters from the hemostat, but on the opposite side of the tendon from where it first entered.

In *B* is shown the other needle starting its first stitch transversely across the tendon, entering only a few fibers transversely away from where the first needle entered (reversed in the diagram). With this needle three diagonal stitches are then taken, just as with the first needle, emerging from the tendon directly opposite where the first needle emerged.

The traumatized cicatricial tip of the tendon is snipped off, as in *C*, and in the insert the stitch is shown as it will be when finally placed.

In *D*, while the tendon is held taut over the finger by one suture, the other suture is passed back through the point where it emerged and is made to emerge from the end of the tendon on that same side.

Each suture is then pulled firmly to remove all slack and is tied to the suture opposite it, which emerges from the end of the other tendon, and the result is as shown in insert.

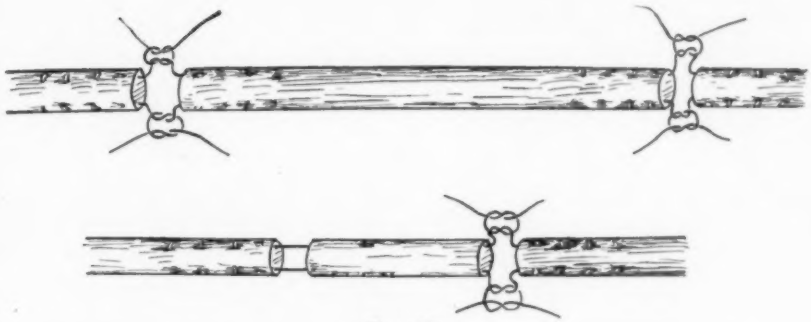

FIG. 12

Method of suturing a free tendon graft to bridge a gap in a tendon. Below is shown method of bridging a short gap. In the latter case after the sutures have been drawn up and tied, each of the two ends of the graft are lightly attached to the tendon end by a single stitch of fine catgut merely to maintain approximation.

### PULLEYS

As we flex our fingers the flexor tendons are kept in their beds by three ligamentous sheaths or pulleys, one at the metacarpal head and one each opposite the middle of the proximal and middle phalanges. If these pulleys are destroyed the tendon will displace forwards like a bow-string and lose its mechanical efficiency.

Pulleys are easily reconstructed by making a loop of free tendon graft and suturing its ends together so that it encircles both the bone and flexor tendon. The suturing is slipped around to one side so that the tendon will glide over a smooth pulley surface. The annular ligaments in the wrist also act as pulleys, one while the wrist is flexed and the other while it is extended, and should be preserved or reconstructed by grafting. If they must be laid open, the cutting should be at one side to preserve the gliding surface.

### INCISIONS

The location of incisions in the hand is important, both when the original infection is drained and when the reconstructive work is done. The most damaging, and still the one most frequently seen, is the pernicious median longitudinal incision. I speak feelingly of this, as it needlessly wrecks so many hands. It is pernicious because it crosses flexion creases at right angles so that flexion contractures result, cuts pulleys where they cannot be repaired, makes roughening and adhesions on the very surface where the tendon glides, and furnishes a maximum length for adhesions to form along the tendon. If, too, it is made along an extensor tendon, it will be impossible to fashion a proper skin flap when later repairing the tendon. An incision should be remote from tendon sutures or grafts, should not cross a flexion crease at right angles, should parallel the creases and be L-shaped in the palm, should never cut the nerves of the hand or fingers and especially the thenar motor branch. In the forearm and wrist short

FIG. 13-A

FIG. 13-B

FIG. 13-C

FIG. 13-D

P. K. Five months previously, from a knife cut in the pulp of the thumb, the contents of the hand and forearm were destroyed by severe infection, which lasted three months. The median nerve and most of the tendons sloughed. The ulnar nerve was spared, but the small hand muscles were practically destroyed. When presented for operation the wrist and fingers were straight and stiff. The thumb was lateral without opposition and could not touch any finger. He could not move the thumb or any finger, had no sensation in the area supplied by the median nerve, and the hand was indurated and of poor nutrition. After the joints were first drawn into functionating positions two operations were performed.

Operation (In two stages four months apart):

At operation the hand and wrist were found to be composed largely of scar tissue. In *A* is shown the findings as regards the flexor tendons and the median nerve. In *B* is shown what was done. In black are shown the tendon grafts taken from the long extensors of the toes. A pulley operation was done to give the thumb opposition. The median nerve was split and sutured to five of its branches. The cicatrix was excised. A capsulotomy was done on the proximal finger joints and a large sheet of paratenon fat was taken from over the triceps tendon and grafted about the flexor tendons in the wrist and base of the palm, separating each from the other and from the surrounding tough tissue. The extensor tendons of the thumb were freed.

Result: Sensation, including stereognosis, was restored over the entire area. The ability to open and close the hand is shown in *C* and *D*. His grip is fifteen kilograms. He shovels coal for a living, and he can pick up articles ranging from a match to an object two and one-half inches in diameter.

transverse ones will often suffice and will become almost invisible. In the fingers mid-lateral incisions are best and they should, unless long, be opposite the joints where there are no pulleys. If pulleys are cut they should be repaired with fine chromic catgut. Lateroventral incisions in fingers will damage the volar vessels and nerves.

### OPPOSITION OF THE THUMB

The use of the thumb, which is our most valued digit, is dependent on its ability to oppose the fingers and this in turn depends on the integrity of the abductor and opponens pollicis muscles and the thenar motor branch of the median nerve that supplies them. Only rarely do fibers from the ulnar

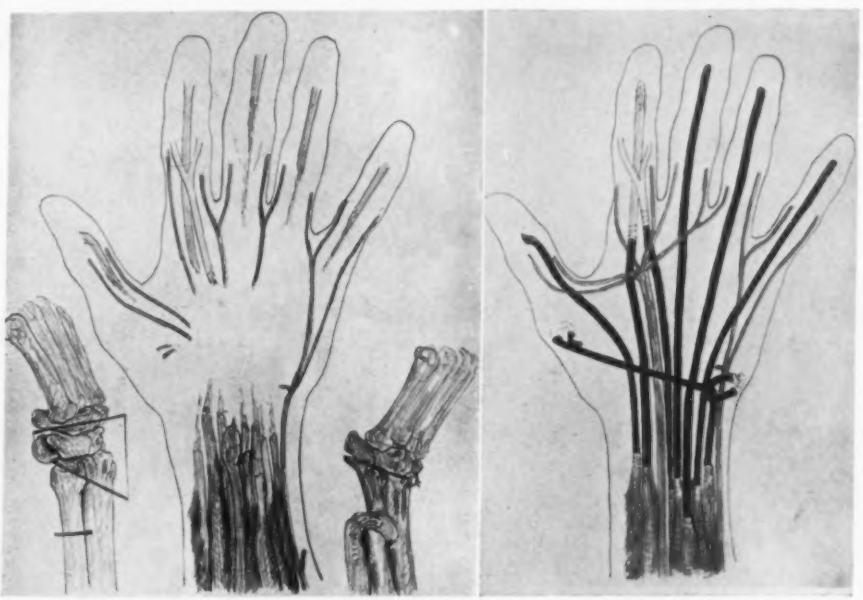

FIG. 14-A FIG. 14-B

H. O., age 36. Two years previously, from a sliver in the volar part of the thumb, an infection caused all the flexor tendons and much of the median nerve to slough from the hand, sparing the ulnar nerve only. The carpus and radio-ulnar joint were ankylosed straight, the proximal finger joints were stiff and straight. The median area was anæsthetic and there was no power of flexion even from the small hand muscles.

Operation (In two stages a year apart):

An excision was made of the scar tissue from hand and wrist, the carpus and the lower end of the ulna. Pronation and supination were then free, the wrist was wired for ankylosis in a cock-up position, and the wrist was so shortened that when the elbow was flexed the median nerve could be sutured to its five branches. At the second operation eight tendon grafts, some eight and one-half inches long, were taken from the extensors of the toes and used to reconstruct the flexor tendons, including a pulley operation for opposition of the thumb.

In *A* and *B* are shown the condition found and the reconstruction done.

Result: Although the state of nutrition in this hand was poor, sensation returned throughout and some degree of stereognosis. The wrist was ankylosed in a functionating cock-up position and pronation and supination were complete. Opposition was restored to the thumb. The grip was fifteen kilograms and the spread between the thumb and the fingers was two inches. He was able to earn his living again as a carpenter.

FIG. 15-A

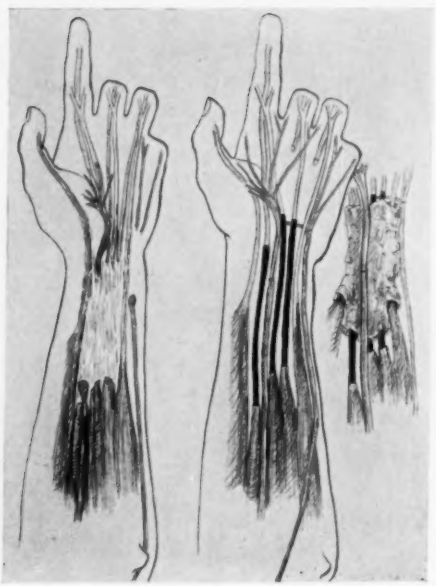

FIG. 15-B

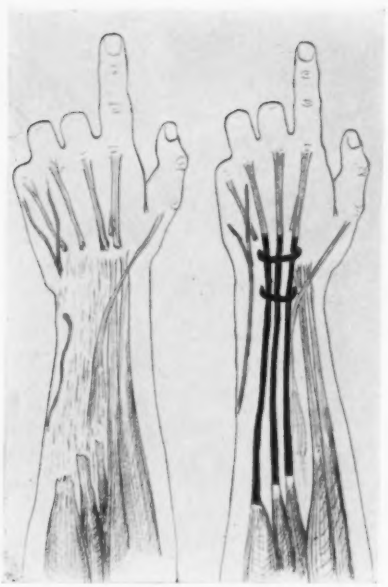

FIG. 15-C

A. T. Eighteen months previously a buzz saw almost severed the hand, passing from the base of the little finger diagonally up the forearm, severing most of the tendons and nerves and also amputating some fingers. Infection followed, and in *A* is shown the degree of crippling. The wrist and finger joints are straight and stiff, there is no pronation and supination, no opposition of the thumb and no sensation, except in the area of the radial nerve. There is no power of motion except a slight trace in the thumb. The hand is a mere insensitive atrophic club.

Operation (In two stages three months apart):

The superficial and deep scar tissue were excised and also the ankylosed head of the ulna, to give him supination, and the wrist was extended. By capsulotomy and continuous traction the proximal finger joints were flexed. The remaining tendons were freed and six tendon grafts from the extensors of the toes served to supplant the parts of the other tendons which had sloughed. Two pulleys on the back of the wrist were also grafted in. By flexing all joints and transplanting the ulnar nerve to the front of the elbow, the dorsal branch of the ulnar nerve, the ulnar nerve and the median nerve were joined by suture. A sheet of paratenon fat from over the triceps tendon was interposed between the flexor tendons. In *B* and *C* are shown the condition found and the reconstruction done.

FIG. 15-D FIG. 15-E FIG. 15-F

Result: *D*, *E* and *F* show the hand a year later. Sensation is restored throughout, later even including stereognosis. He has 135 degrees of pronation and supination and 78 degrees of motion at the wrist and the grasp is strong. The thenar muscles have regenerated, restoring opposition to the thumb. He makes a living as a peddler, can button his clothes with this hand, pick up change from his other hand, and, considering his disability, has very good function.

nerve enervate these muscles. Suture of the median nerve above the wrist has returned the power of opposition in sixty per cent. of my series. In the other forty per cent. and also in cases where the thenar motor branch if damaged cannot be sutured, or where the muscles are ruined, we must resort to other means of restoring opposition. As ankylosis at the base of the thumb is unsatisfactory and as a free graft of fascia, as a check-rein, from the end of the metacarpal of the thumb to the pisiform bone, will not furnish motion, these measures are but last resorts; so my method of choice is as follows:

In the position of opposition the thumb is adducted but stands far forwards from the palm, and the thumb nail is parallel to the palm. The direction of the only pull that will accomplish this is in a line from the back of the distal end of the metacarpal to the pisiform bone. This is readily accomplished by running one of the flexor tendons of the forearm through a pulley at the pisiform bone, and then running the tendon or its prolongation by a free tendon graft subcutaneously to the dorsum of the distal end of the metacarpal of the thumb, and there passing it through a drill hole and suturing. The pulley is merely a loop of tendon graft looped about the origin of the abductor minimi digiti. I usually use the flexor ulnaris muscle and this does not lose its natural function, and sometimes use the sublimus of the ring finger, but the palmaris longus may be used together with the palmar fascia as its prolongation. In some cases as a substitute for a pulley, the distal inch of the palmaris longus tendon may be used, leaving its insertion intact and anchoring its cut end to the pisiform bone. We can then use the proximal part of the palmaris longus by prolonging it with a free tendon graft. These methods I have used many times and they give excellent opposition. The action is similar to that of the omohyoid in the neck. The use of the extensor brevis pollicis for opposition gives a weak thumb, as the thenar eminence will ride forwards, just as it does when the short extensors of the thumb are severed (Fig. 6). The method of using the split end of the tendon of the flexor longus pollicis has the objection that a

FIG. 16-A

C. B. A year previously while duck hunting his shotgun discharged through his right carpus. In *A* is shown the result. The joints are stiffened in non-functionating positions and there is no movement of supination. The hand and wrist are completely without motion, there is no sensation in the area supplied by the median nerve, a wide cicatrix with a discharging sinus covers the dorsum of the wrist and a smaller one is in front. The hand is completely useless.

Operation (In several stages):

After excising the sinus and diseased carpus, good skin was replaced over the wrist by a pedicle graft, as shown in *H*, and joints were drawn into functionating positions.

The cicatrix was excised from the hand and forearm both ventrally and dorsally. In *B* is shown the condition of the tendons and median nerve found in the palmar aspect. The median nerve was sutured, tendons were freed from scar, and seven tendon grafts from the long extensors of the toes were placed, as shown in *C* and *D*. The distal parts of the sublimus tendons were excised. Capsulotomies were done on the proximal finger joints and a segment was removed from the lower end of the ulna to give pronation and supination.

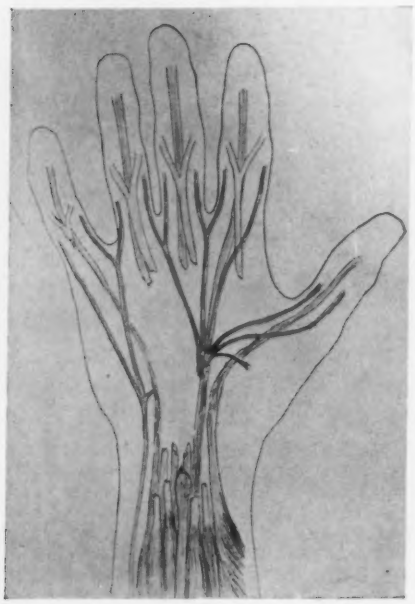

FIG. 16-B

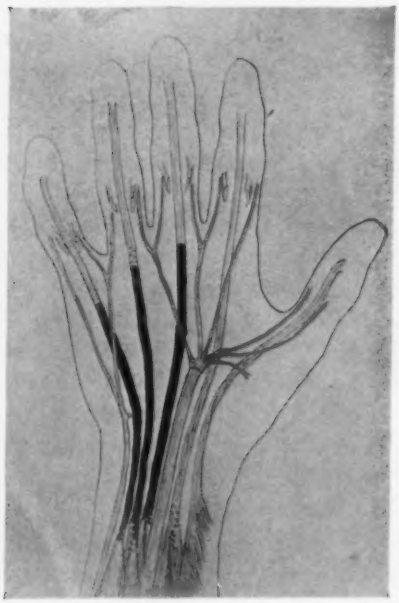

FIG. 16-C

FIG. 16-D

FIG. 16-E

FIG. 16-F

FIG. 16-G

FIG. 16-H

Result: In *E*, *F*, *G* and H the hand is shown two years afterward. The wrist is in a cock-up position and has ten degrees of motion. He has 125 degrees of pronation and supination and the thenar muscles have been restored through the nerve suture. Nutrition and good natural sensation are present throughout, and he can distinguish by touch in the median area a pencil, knife, a quarter or fifty cent piece. He can pick up objects from a match to a tumbler and has a spread of three and one-half inches between the thumb and index finger. He throws a baseball, uses plyers, wrench or hammer, holds nails, writes well with this hand and does rough labor of riveting and reaming.

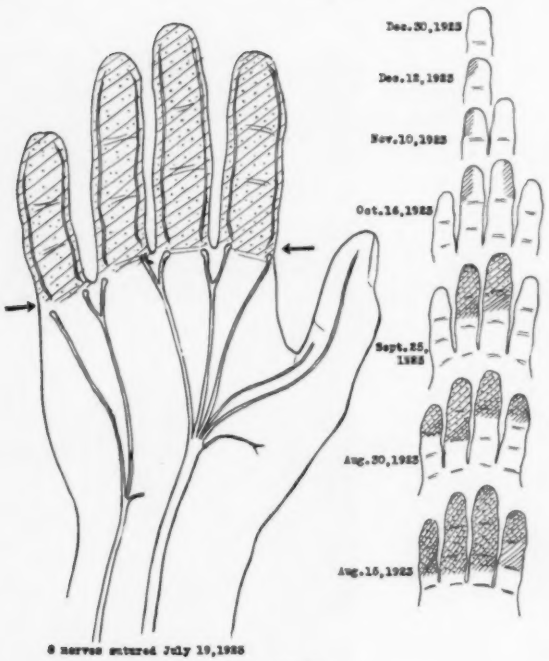


FIG. 17-A

(By courtesy of *Surgery, Gynecology and Obstetrics.*)

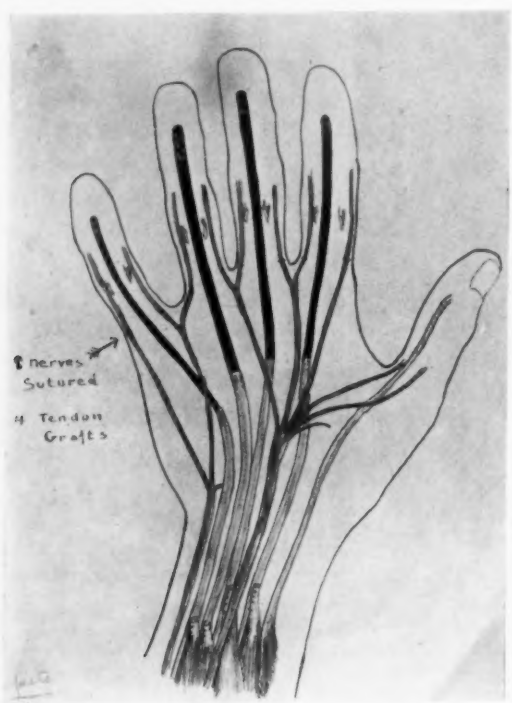


FIG. 17-B

J. T., age 25. Forty-two days previously the hand was caught under the sharp edge of a large rotating pipe and every flexor tendon and every volar nerve was severed at the base of each finger, rendering the fingers useless.

The eight volar nerves were sutured on July 19, 1923. Their ends were approximated by flexing the fingers. The anaesthesia to cotton wool (shaded) and analgesia to pin prick (dotted) receded, as shown by the dates on the diagram in *A*.

On December 15, 1923, the remains of all the flexor tendons were removed from the four fingers and in their places free grafts of the sublimus tendons were used to prolong the profundus tendons to the ends of the fingers (*B*). This operation had to be delayed until the nerves had regenerated or else it would have failed from lack of trophic supply. Good sensation and motion were obtained in each finger. Eventually the fingers could flex almost to the palm.

single tendon cannot to advantage use two insertions of different function and also that it does not pull in the right direction.

### PEDICLE SKIN GRAFTS

In hands with much superficial cicatrix and in those with flexion contracture, it is necessary before reconstructing the tendons to excise the cicatricial and contracting skin and subcutaneous scar tissue and to replace them with new skin by the pedicle method, preferably from the abdomen. Tubular pedicles are used, since by eliminating all raw areas asepsis is maintained, and so fibrosis and keloid formation are less. Pedicle skin grafts relieve flexion contractures and furnish a soft fatty bed through which the reconstructed tendons may have mobility. They also relax all of the tissues in the vicinity that have been bound tightly by the superficial and deep contracting cicatrix. By this relief of tension and liberation of circulation and nerve action, the nutrition of the whole hand or forearm is greatly improved. Keloids form in response to tension, so by relaxing the tension of the tissues not only is keloid of the skin prevented, but in addition we prevent excessive deep cicatrization, which, like a keloid, increases in response to tension. Single keloid bands of tension and webs in the skin may be relieved by excising the hardened tissue and performing a zigzag plastic.

### STIFFENED JOINTS

Stiffened joints must be mobilized before tendons are reconstructed. When the stiffening is due to general thickening of the capsules, force is contraindicated and the daily pump-handle traumatizing of the physiotherapist produces microscopic tears, which are followed by the physiological reaction of more scar formation and the stiffening is increased. Results can be obtained by using splints and appliances which apply to the joint mild and continuous force over a period of several weeks, just as the dentist moves teeth about the mouth. Intermittent force merely stretches the restraining tissues and they recoil to their former length, but continuous force holds them drawn out until they grow longer.

Crippled hands usually assume the typical non-functionating position. The wrist is straight or flexed, the proximal finger joints are extended, the two distal ones are flexed, and the thumb assumes the lateral position. Ulnar paralysis results in the same claw-shaped hand as does infection, and it is little wonder, as in each case the position is due to paralysis of the small hand muscles. In the latter case these same muscles cease functionating from being bathed in pus.

Joints in non-functionating positions will not be used. We should first place them in the position of function, and then the patient by use will mobilize them. Splints worn too continuously or too long will stiffen joints.

The wrist should be cocked up, the proximal finger joints flexed and

FIG. 18-A

FIG. 18-B

FIG. 18-C

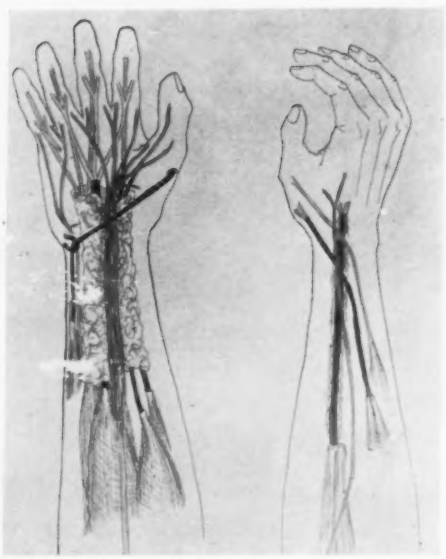

FIG. 18-D

E. B., age 23. Four years previously a buzz saw passed two-thirds through the carpus from the radial side, and a considerable length of the median and radial nerves and of most of the tendons sloughed out. The hand was totally useless. There was atrophy and absence of sensation except in the ulnar area, no pronation and supination and practically no motion, as shown in *A* and *B*, which show the hand and wrist in full flexion and full extension, respectively.

Operation (In two stages six months apart): *C* and *D*.

Superficial and deep scar tissue were excised from both the front and back. A segment of ulna was removed to give pronation and supination and joints were placed in functionating positions. The only tendons remaining were the extensors of the fingers, the long extensor of the thumb, and two roughened strands of flexors to the long and ring fingers. The deficiencies of the other tendons were made up by free grafts from the extensor tendons of the foot with their paratenon. In *D* the graft into the extensors of the wrist is shown to be surrounded with its paratenon. Another free graft was joined to the flexor ulnaris muscle in constructing a pulley operation for opposition of the thumb. A wide sheet of paratenon fat was grafted from over the triceps tendon and interwoven about the flexor tendons to furnish mobility. A six-inch, three-ply nerve graft was used to bridge the gap in the median and another graft was placed to bridge that in the radial nerve, as explained in Fig. 19 and Fig. 20.

FIG. 18-E

FIG. 18-F

FIG. 18-G

Result: The hand became so useful to him that he changed his outlook on life and instead of becoming a teacher became a lawyer. The thumb could spread two and one-quarter inches from the index finger and flexed until its distal joint was at 97 degrees. The grip measured twenty kilograms, good sensation returned throughout and he could use his hand for all of his ordinary needs, as shown in *E*, *F* and *G*.

the thumb should be drawn into opposition. The latter can be done by an adhesive band looped about the metacarpal head, and so anchored around the hand and wrist that the thumb is drawn in opposition. This will also restore the flattened carpal and metacarpal arches. Proximal finger joints[10] may be bent first by drawing together by web belt and buckle an angulated sheet of metal on the dorsum of the hand and a metal cross bar across the palm, so that the three pressure points which are padded are the heads of the metacarpals in front, and in back the distal ends of the proximal phalanges and proximal ends of the metacarpals. After some angulation is obtained, the joints can be further drawn into flexion by placing a web belt and buckle about the wrist of the gloved hand and by using this buckle to attach strings that pull from the tips of the fingers of the glove.

If the proximal finger joints prove too resistant for the above method, pieces may be excised from the dorsal part of their capsules. If these joints are ankylosed an arthroplasty will restore to them seventy degrees of motion. If pronation and supination are prevented by an ankylosis of the distal radio-ulnar joint, they can be completely restored by removing a segment from the lower end of the ulna.

## GENERAL TECHNIQUE

A very exact technique is necessary in restoring function to crippled hands. Tendon and fat grafts are extremely susceptible to infection, so the asepsis must be rigid to its last detail. A frank infection in such cases is a catastrophe, but a mild one, not to the degree of necessitating drainage, will result in binding fibrosis and so will prevent movement of tendons. Trauma also results in fibrosis as each insult to live tissue is followed by a physiological reaction which results in cicatrix. An atraumatic technique[7] includes not only protecting the tissues from macroscopic trauma but also from microscopic trauma and we should regard them from this histologic view-point. The patient's hand should be held absolutely steady. Any tremor means trauma and makes uncertainty in the aim of the instrument.

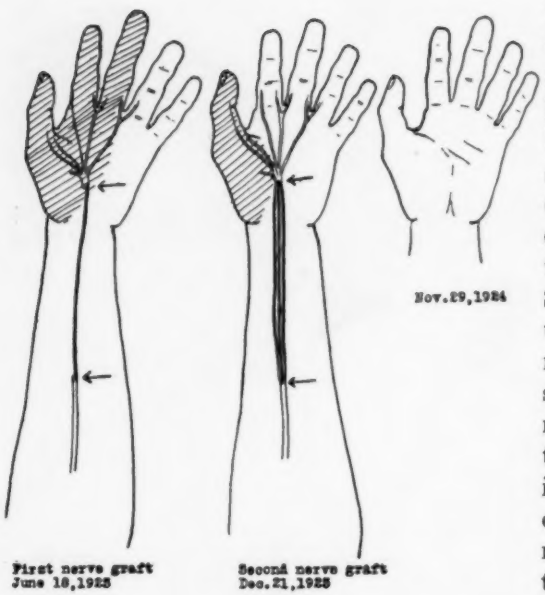


FIG. 19

(By courtesy of *Surgery, Gynecology and Obstetrics.*)

E. B., age 23. (Same case as in Figs. 18 and 20.) Four years previously a buzz saw passed two-thirds through the carpus from the radial side and a considerable length of the median and radial nerves and most of the tendons sloughed out. On June 18, 1923, while joining the flexor tendons with grafts from extensor tendons of the foot, a single strand of sural nerve six inches long was grafted between the median nerve in the forearm and its distal end in the palm, as shown between the arrows in *A*.

The anaesthetic area diminished, as shown in *B;* so encouraged by this, two more strands of sural nerve from the other leg were grafted in six months later (Dec. 21, 1923), making a three-ply, six-inch graft.

In eleven months he felt light touch and pin prick over the entire area and identified a half dollar and called a knife a key. At the end of one and one-half years stereognosis was good and, although his fingers moved largely through six tendon grafts, he was able by feeling to tie his shoe laces, shave, use a typewriter and pick up a match or large object with that hand.

The structures are too tiny to allow even the miss of a millimeter, so the field and hands of the operators should be braced. Movements should be efficient and reduced to the minimum, as every touch adds traumatism. Speed is a necessity. Such an operation is made up of "a thousand" little movements and each consumes time. To be atraumatic we must also reduce time of operation, the drying of tissues, thermal and chemical irritation, the duration of the ischemia, and the amount of hematoma left at the end.

All dissecting must be done under ischemia to furnish perfect vision of the tissues and to avoid the trauma of sponging. The nerves and other structures will surely be damaged if we work in the opacity of blood. After winding the limb with an Esmarch bandage from the fingers to the elbow a blood-pressure band is placed on the upper arm and pumped to 250 millimeters Hg. The tubes are clamped and the Esmarch is removed. All of the dissecting and fine work should be completed before the tourniquet is released, and this should not be longer than an hour, or some degree of induration and reaction will result. On releasing the tourniquet the wound should be held firmly with sponges until hemorrhage from the smaller vessels has stopped. Triple O catgut controls the rest. Hematoma causes considerable after-trouble, so wounds should be closed dry, or if this is impossible a twenty-four hour silkworm gut drain should be placed remotely from the tendons and a moderately firm compression bandage applied.

For joining tendons I use No. 3 Turner's patent ligature silk and braid

it into the tendon for a distance of three or four stitches. In order to protect the delicate epitenon the scar tip of the tendon is grasped with a Kocher hemostat and while the tendon is held taut the stitch is placed. Starting a centimeter or slightly more back, passing each end of the silk in a zigzag manner on a straight cambric needle through the tendon, each end of the silk finally emerges near the end of the tendon and each on opposite sides. Each stitch leaves and enters the tendon at nearly the same place, crossing only a few tendon fibers, so that a minimum of silk will be exposed. The end of the tendon pinched by the hemostat is cut off two millimeters beyond where the silk emerges. The needles are again inserted and the silk is made to emerge from the ends of the tendon, still on opposite sides. The other tendon end is treated similarly, and each silk thread is pulled firmly to remove all the slack that is to come.

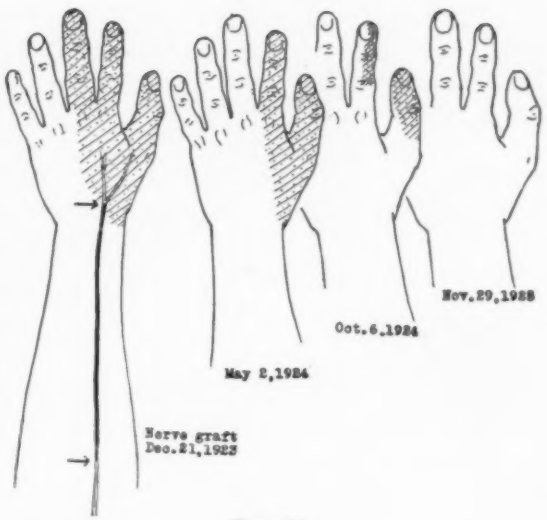


FIG. 20

(By courtesy of *Surgery, Gynecology and Obstetrics.*)

E. B. (Same case as in Figs. 18 and 19.) On December 21, 1923, while supplying tendon grafts for the thumb and extensors of the wrist a six-inch graft of sural nerve was used to join the ends of the superficial radial nerve, as shown between the arrows.

The area of anaesthesia shown is extensive for this nerve, as the median nerve was also severed. The anaesthesia to cotton wool (shaded) and pin prick (dotted) receded, as shown by the dates on the diagrams.

Each tendon end now has two silk sutures emerging from its end. The tendon ends are approximated to each other and all tension is removed from the tendon by bending the joints. The silk sutures are tied together each to the one opposite it. The result is a strong smooth union, with the tendon untraumatized, the knots buried, a minimum of silk on the surface and with the least strangling effect. The union will be sufficiently strong to admit early exercise during the necessary four or five weeks for physiological union to occur. Later the union is hardly visible.

Postoperative splints are used for extensor tendons only, to guard them from breaking under the strong pull of the flexors. For flexor tendons the wrist is merely kept in flexion for a month by means of an adhesive band, or an angulated flat metal dorsal splint and exercise is started the next day and kept up. This robs the muscle of its strength but allows full amplitude of motion. Some necrosis takes place in the bite of the stitch in the first few days, but movement is too painful then to be harmful.

Soon the necrotic part is absorbed and good tendon tissue takes its place, so eventually the silk is seen microscopically to be imbedded in practically normal tendon tissue. In order to keep the tendon mobilized in the finger, the finger must frequently be voluntarily flexed while the proximal one and two segments are passively held in extension, or else all of the movement will take place at the proximal joints. At the end of two weeks the tendon moves the least and from then on the adhesions gradually decrease. Complete results are often not obtained until all induration has gone and the adhesions have yielded. This often requires a year.

### EXTENSIVE CASES

To properly diagnose, measure, record and photograph a badly crippled hand requires an hour and to reconstruct it may consume a year. It will first be necessary to relieve flexion contractures and replace cicatrices by pedicle grafts. Over a period of weeks joints are placed in functionating positions and mobilized. Many operations will be necessary and time must elapse between each for nerves to regenerate and induration to subside. In an atrophic finger we must not repair the tendon or place a tendon graft until after the nerves have been repaired and have had time to regenerate, for if we do, our healing will be cicatricial and our graft will degenerate or even break. The operations themselves are several hours long and very fatiguing. As long as the tourniquet is on, one works under the stress of speed to accomplish as much as possible, including dissection and nerve suture, before the flow of blood obscures one's vision. To the patient with a mere club for a hand with stiffened joints, no motion, no sensation, and poor nutrition, it means much if we can restore to him even sensation and ability to grasp. The loss of a leg is small compared to the loss of a hand.

### PROGNOSIS

The prognosis depends on several factors.

Only by great care on the part of the surgeon and continued attention to the endless number of details involved in this tedious type of work will the reward of having grateful patients be obtained. Success is somewhat dependent also on the part of the patient. If fear of pain is paramount and the will-power weak, he will not exercise the hand sufficiently or strongly enough to mobilize the tendons. One must take some punishment for the reward of a good result. There are other patients who are prone to form cicatrix and whose joints have an unusual tendency to stiffen. Results in this type fall short of the average.

The main factor in prognosis is the state of nutrition in the hand and the amount of cicatrix within it. In extreme cases where the hand has been thoroughly gutted by infection and its contents replaced by cicatrix, its nerves and tendons destroyed, its joints stiffened and its general nutrition greatly reduced, we should be able to restore to it functionating

positions of the joints, a useful degree of sensation, and the ability to grasp objects and to open the hand from two to five inches.

If a finger is quite cicatricial but has flexible joints one can replace its damaged tendon and probably give it flexion to within a half inch from the palm. If its joints are stiffened beyond repair less is to be expected.

If the general condition of the hand is normal with the exception of a few damaged tendons and nerves, we can expect to regain most of the tendon and nerve function.

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## DISCUSSION

Dr. Leo Mayer, New York, N. Y.: It is too late for me to begin to say anything about Dr. Bunnell's paper. Dr Bunnell and I are, I think, a little bit crazy on the subject of tendons and I know if I begin to talk I will never stop. I am, however, so full of admiration that it is hard to refrain from talking. Dr. Bunnell's work is famous the world over. There is no one who can do what he can. He was the first one to attempt the repair of the digital nerves. He was the first one to attempt the extensive repair of the tendons of the hand. Some years ago when I was taking luncheon with Dr. Alexis Carrel we spoke about tendon suture and he said that arterial suture was an easy job compared to the repair of tendons. Those of you who will see Bunnell's work in San Francisco will see how he is able to achieve results. It is accomplished by a

technique that rivals that of the most proficient musician. It can be learned not by reading papers or attempting operations but only by years of conscientious practice on the cadaver until we can imitate the atraumatic technique of which he is master.

Dr. Arthur Steindler, Iowa City, Ia.: To say that Dr. Bunnell is a master of tendon surgery would be to repeat what Dr. Mayer said and what everybody else knows. He has not only made use of known biologic facts which have been greatly disregarded in the reconstruction of the hand but he has also greatly enlarged upon our view of the regenerative possibilities. His excision of scar tissue until healthy tissue is encountered is a fact that is well known but is not generally heeded. That is one of the great points in his tendon reconstruction besides the technical finesse which Dr. Mayer has dwelt upon.

That we may expect regeneration of a sensory nerve as fine as a digital sensory nerve is a thing we had not expected. He has taught us the value of reconstruction of the sensory portion of the hand and furthermore, he points out, step after step how functional reconstruction follows the sensory repair. I do not think I could possibly within the limits of the short time of discussion even touch upon the many important factors he has brought out. His technique is admirable and unequaled, but the recognition of the principles of biology which underlie his technique is still the greater thing. I can only repeat what Dr. Mayer said, that I consider him the best technician and also the best scientist in the reconstruction of injuries and disabilities in the hand.

# DISABILITY AND COST OF INDUSTRIAL FRACTURES*

## A Comparison Based Upon an Impersonal Study of Statistics of Fractures Treated by the Specially Trained Surgeon and the General Practitioner

BY ROSCOE N. GRAY, M.D., SAN FRANCISCO, CALIF.

*Medical Referee, Aetna Life Insurance Company*

In the broad field of traumatic surgery is the work of the surgeon specially trained in the treatment of fractures superior to that of the general surgeon? The obvious measure of a surgeon's ability is the period of disability suffered by his patients.

The duty of the medical department of a Workmen's Compensation Insurance Company is to seek out those doctors who return their patients to work at the earliest possible date. Our office has felt for many years that the specialist, even though he tends to be more expensive, is the cheapest in the end, on the grounds that he reduces the period of disability and minimizes permanent injuries.

One of the practical questions is what types of injuries should be transferred. You will agree that it would be impossible to refer every case, and it is no easy task to determine which ones to leave in the hands of the country doctor.

We studied 34,753 compensation files from Northern California in an effort to find the answer. The tabulation which follows shows certain conclusions which are used for the purposes of this paper. First, it should be briefly explained how the table was built up. When an accident is reported, the file is coded according to diagnosis. All of those coded as fractures were tabulated according to the bone involved. We desired to learn whether the disability, both temporary and permanent, was different in the city and country. So three subdivisions were made, according to where the accident happened; San Francisco, where specialists treated nearly all cases of magnitude; city cases, representing injuries sustained in the five other large cities, where excellent general surgeons were in attendance; and lastly the small town or village cases.

Each of these groups was further subdivided according to the type of doctor who treated the case. Thus we made a subdivision for those treated by a general surgeon only, a second for those referred to a surgeon specially trained in the treatment of fractures, within two weeks, and a third for those referred after two weeks. The disability and cost were then entered under these last headings.

*Read before the meeting of the American Orthopaedic Association, Yosemite Valley, California, June, 1927.

## AVERAGE DISABILITY AND COST OF INDUSTRIAL FRACTURES

Compiled from Records of 34,753 Compensation Cases, Northern California
Aetna Life Insurance Company
1917 through 1926

| *Bone* | | *Disability* Temp. | Perm. | *Total* Med. Exp. | *Paid* Doctor | Comp. |
|---|---|---|---|---|---|---|
| Femur | Average All Cases | 54.1 | 57.1 | $795.59 | $309.86 | $1,148.04 |
| | Open Treatment | 99.3 | 105.0 | 2,248.68 | 836.45 | 2,274.76 |
| | S. F. Surgeon Only | 19.0 | 00.0 | 341.38 | 86.87 | 335.71 |
| | Referred before 2 weeks | 39.1 | 22.0 | 659.55 | 255.65 | 779.55 |
| | Referred after 2 weeks | 00.0 | 00.0 | 000.00 | 000.00 | 000.00 |
| | Average for S. F. | 32.2 | 14.3 | 553.35 | 199.39 | 631.61 |
| | City Surgeon Only | 17.5 | 00.0 | 469.50 | 129.50 | 295.30 |
| | Referred before 2 weeks | 00.0 | 00.0 | 000.00 | 000.00 | 000.00 |
| | Referred after 2 weeks | 92.0 | 127.0 | 1,148.33 | 478.75 | 2,645.41 |
| | Average for City | 54.6 | 63.3 | 808.91 | 304.12 | 1,470.35 |
| | Town Physician Only | 21.5 | 27.4 | 224.29 | 98.18 | 503.40 |
| | Referred before 2 weeks | 11.6 | 00.0 | 369.32 | 187.95 | 147.46 |
| | Referred after 2 weeks | 132.0 | 109.0 | 2,504.52 | 885.00 | 2,139.72 |
| | Average for Town | 135.6 | 109.5 | 1,494.52 | 588.39 | 2,080.04 |
| Patella | Average All Cases | 41.6 | 34.3 | 521.85 | 227.75 | 861.51 |
| | Open Treatment | 41.6 | 34.3 | 521.85 | 227.75 | 861.51 |
| | S. F. Surgeon Only | 00.0 | 00.0 | 000.00 | 000.00 | 000.00 |
| | Referred before 2 weeks | 67.2 | 69.0 | 856.01 | 341.50 | 1,437.27 |
| | Referred after 2 weeks | 00.0 | 00.0 | 000.00 | 000.00 | 000.00 |
| | Average for S. F. | 67.2 | 69.0 | 856.01 | 341.50 | 1,437.27 |
| | City Surgeon Only | 16.3 | 00.0 | 157.70 | 114.00 | 285.75 |
| | Referred before 2 weeks | 00.0 | 00.0 | 000.00 | 000.00 | 000.00 |
| | Referred after 2 weeks | 00.0 | 00.0 | 000.00 | 000.00 | 000.00 |
| | Average for City | 16.3 | 00.0 | 157.70 | 114.00 | 285.75 |
| | Town Physician Only | 00.0 | 00.0 | 000.00 | 000.00 | 000.00 |
| | Referred before 2 weeks | 00.0 | 00.0 | 000.00 | 000.00 | 000.00 |
| | Referred after 2 weeks | 00.0 | 00.0 | 000.00 | 000.00 | 000.00 |
| | Average for Town | 00.0 | 00.0 | 000.00 | 000.00 | 000.00 |
| Tibia | Average All Cases | 13.2 | 00.0 | 115.62 | 58.42 | 197.31 |
| | Open Treatment | 00.0 | 00.0 | 000.00 | 000.00 | 000.00 |
| | S. F. Surgeon Only | 11.4 | 00.0 | 69.50 | 56.50 | 96.88 |
| | Referred before 2 weeks | 9.3 | 00.0 | 111.45 | 74.87 | 154.64 |
| | Referred after 2 weeks | 00.0 | 00.0 | 000.00 | 000.00 | 000.00 |
| | Average for S. F. | 10.0 | 00.0 | 97.47 | 68.75 | 135.38 |
| | City Surgeon Only | 15.6 | 00.0 | 131.46 | 60.52 | 263.49 |
| | Referred before 2 weeks | 00.0 | 00.0 | 000.00 | 00.00 | 000.00 |
| | Referred after 2 weeks | 00.0 | 00.0 | 000.00 | 00.00 | 000.00 |
| | Average for City | 15.6 | 00.0 | 131.46 | 60.52 | 263.49 |
| | Town Physician Only | 13.0 | 00.0 | 130.80 | 50.20 | 184.15 |
| | Referred before 2 weeks | 00.0 | 00.0 | 000.00 | 00.00 | 000.00 |
| | Referred after 2 weeks | 00.0 | 00.0 | 000.00 | 00.00 | 000.00 |
| | Average for Town | 13.0 | 00.0 | 130.80 | 50.20 | 184.15 |
| Fibula | Average All Cases | 8.0 | 00.0 | 101.09 | 50.88 | 128.27 |
| | Open Treatment | 00.0 | 00.0 | 000.00 | 00.00 | 000.00 |
| | S. F. Surgeon Only | 10.0 | 00.0 | 97.65 | 52.55 | 144.50 |
| | Referred before 2 weeks | 5.6 | 00.0 | 52.45 | 42.70 | 82.47 |
| | Referred after 2 weeks | 00.0 | 00.0 | 00.00 | 00.00 | 000.00 |
| | Average for S. F. | 8.3 | 00.0 | 81.37 | 43.79 | 120.42 |
| | City Surgeon Only | 8.4 | 00.0 | 122.71 | 70.55 | 136.07 |
| | Referred before 2 weeks | 0.0 | 00.0 | 000.00 | 00.00 | 000.00 |
| | Referred after 2 weeks | 0.0 | 00.0 | 000.00 | 00.00 | 000.00 |
| | Average for City | 8.4 | 00.0 | 122.71 | 70.55 | 136.07 |
| | Town Physician Only | 7.2 | 00.0 | 99.77 | 42.37 | 127.91 |
| | Referred before 2 weeks | 7.5 | 00.0 | 124.55 | 80.20 | 139.86 |
| | Referred after 2 weeks | 0.0 | 00.0 | 000.00 | 00.00 | 000.00 |
| | Average for Town | 7.3 | 00.0 | 120.03 | 45.81 | 129.00 |

| *Bone* | | *Disability* Temp. | Perm. | *Total* Med. Exp. | *Paid* Doctor | Comp. |
|---|---|---|---|---|---|---|
| Tibia and Fibula | Average All Cases | 34.0 | 16.4 | $454.42 | $225.41 | $622.64 |
| | Open Treatment | 44.4 | 28.3 | 640.91 | 325.55 | 892.25 |
| | S. F. Surgeon Only | 13.5 | 00.0 | 130.51 | 76.94 | 220.89 |
| | Referred before 2 weeks | 19.6 | 00.0 | 374.09 | 201.05 | 337.10 |
| | Referred after 2 weeks | 00.0 | 00.0 | 000.00 | 000.00 | 000.00 |
| | Average for S. F. | 16.3 | 00.0 | 238.77 | 133.21 | 272.54 |
| | City Surgeon Only | 41.5 | 39.1 | 401.95 | 208.13 | 960.35 |
| | Referred before 2 weeks | 62.3 | 00.0 | 1,298.61 | 627.80 | 1,151.60 |
| | Referred after 2 weeks | 44.1 | 33.0 | 436.17 | 254.62 | 1,041.01 |
| | Average for City | 42.5 | 34.0 | 498.46 | 259.39 | 995.61 |
| | Town Physician Only | 47.3 | 19.5 | 546.86 | 265.91 | 443.28 |
| | Referred before 2 weeks | 29.4 | 00.0 | 1,309.20 | 564.50 | 568.65 |
| | Referred after 2 weeks | 17.3 | 00.0 | 407.53 | 143.90 | 277.77 |
| | Average for Town | 40.3 | 19.5 | 590.84 | 270.87 | 570.04 |
| Os Calcis | Average All Cases | 12.6 | 00.0 | 116.90 | 71.99 | 209.86 |
| | Open Treatment | 00.0 | 00.0 | 000.00 | 00.00 | 000.00 |
| | S. F. Surgeon Only | 7.2 | 00.0 | 68.25 | 64.00 | 130.93 |
| | Referred before 2 weeks | 19.2 | 00.0 | 430.00 | 254.40 | 380.89 |
| | Referred after 2 weeks | 00.0 | 00.0 | 000.00 | 000.00 | 000.00 |
| | Average for S. F. | 11.2 | 00.0 | 188.83 | 127.47 | 214.25 |
| | City Surgeon Only | 18.7 | 00.0 | 48.50 | 33.67 | 263.23 |
| | Referred before 2 weeks | 00.0 | 00.0 | 00.00 | 00.00 | 000.00 |
| | Referred after 2 weeks | 00.0 | 00.0 | 00.00 | 000.00 | 000.00 |
| | Average for City | 18.7 | 00.0 | 48.50 | 33.67 | 263.23 |
| | Town Physician Only | 10.2 | 00.0 | 111.46 | 46.25 | 123.21 |
| | Referred before 2 weeks | 00.0 | 00.0 | 000.00 | 00.00 | 000.00 |
| | Referred after 2 weeks | 00.0 | 00.0 | 000.00 | 00.00 | 000.00 |
| | Average for Town | 10.2 | 00.0 | 111.46 | 46.25 | 123.21 |
| Astragalus | Average All Cases | 14.4 | 28.5 | 300.85 | 139.15 | 644.94 |
| | Open Treatment | 10.0 | 49.0 | 552.40 | 322.85 | 1,020.67 |
| | S. F. Surgeon Only | 00.0 | 00.0 | 000.00 | 000.00 | 000.00 |
| | Referred before 2 weeks | 00.0 | 00.0 | 000.00 | 000.00 | 000.00 |
| | Referred after 2 weeks | 00.0 | 00.0 | 000.00 | 000.00 | 000.00 |
| | Average for S. F. | 00.0 | 00.0 | 000.00 | 000.00 | 000.00 |
| | City Surgeon Only | 21.4 | 33.0 | 307.49 | 106.87 | 768.90 |
| | Referred before 2 weeks | 00.0 | 00.0 | 000.00 | 000.00 | 000.00 |
| | Referred after 2 weeks | 00.0 | 00.0 | 000.00 | 000.00 | 000.00 |
| | Average for City | 21.4 | 33.0 | 307.49 | 106.87 | 768.90 |
| | Town Physician Only | 4.0 | 00.0 | 36.03 | 20.00 | 21.30 |
| | Referred before 2 weeks | 00.0 | 00.0 | 00.00 | 000.00 | 000.00 |
| | Referred after 2 weeks | 10.0 | 49.0 | 552.40 | 322.85 | 1,020.67 |
| | Average for Town | 7.0 | 24.3 | 294.21 | 171.42 | 520.98 |
| Other Tarsals | Average All Cases | 9.1 | 00.0 | 125.41 | 52.35 | 286.25 |
| | Open Treatment | 0.0 | 00.0 | 000.00 | 00.00 | 000.00 |
| | S. F. Surgeon Only | 0.0 | 00.0 | 000.00 | 00.00 | 000.00 |
| | Referred before 2 weeks | 12.2 | 00.0 | 169.00 | 58.45 | 490.99 |
| | Referred after 2 weeks | 0.0 | 00.0 | 000.00 | 00.00 | 000.00 |
| | Average for S. F. | 12.2 | 00.0 | 169.00 | 58.45 | 490.99 |
| | City Surgeon Only | 0.0 | 00.0 | 20.75 | 15.00 | 000.00 |
| | Referred before 2 weeks | 0.0 | 00.0 | 00.00 | 00.00 | 000.00 |
| | Referred after 2 weeks | 0.0 | 00.0 | 00.00 | 00.00 | 000.00 |
| | Average for City | 0.0 | 00.0 | 20.75 | 15.00 | 000.00 |
| | Town Physician Only | 12.0 | 00.0 | 142.90 | 77.50 | 163.02 |
| | Referred before 2 weeks | 00.0 | 00.0 | 000.00 | 00.00 | 000.00 |
| | Referred after 2 weeks | 00.0 | 00.0 | 000.00 | 00.00 | 000.00 |
| | Average for Town | 12.0 | 00.0 | 142.90 | 77.50 | 163.02 |

| *Bone* | | *Disability* Temp. | Perm. | *Total* Med. Exp. | *Paid* Doctor | Comp. |
|---|---|---|---|---|---|---|
| Metatarsals | Average All Cases | 10.1 | 4.2 | $80.60 | $51.07 | $171.76 |
| | Open Treatment | 30.0 | 25.3 | 361.96 | 143.52 | 441.62 |
| | S. F. Surgeon Only | 8.0 | 00.0 | 70.94 | 46.79 | 126.18 |
| | Referred before 2 weeks | 5.3 | 00.0 | 41.09 | 22.41 | 70.59 |
| | Referred after 2 weeks | 8.6 | 00.0 | 122.45 | 96.70 | 87.37 |
| | Average for S. F. | 7.0 | 00.0 | 62.44 | 40.10 | 101.36 |
| | City Surgeon Only | 19.3 | 11.4 | 79.30 | 59.96 | 296.94 |
| | Referred before 2 weeks | 00.0 | 00.0 | 00.00 | 00.00 | 000.00 |
| | Referred after 2 weeks | 00.0 | 00.0 | 00.00 | 00.00 | 000.00 |
| | Average for City | 19.3 | 11.4 | 79.30 | 59.95 | 296.94 |
| | Town Physician Only | 6.4 | 00.0 | 68.92 | 44.00 | 110.45 |
| | Referred before 2 weeks | 0.0 | 00.0 | 00.00 | 00.00 | 000.00 |
| | Referred after 2 weeks | 51.0 | 51.0 | 590.05 | 225.50 | 741.00 |
| | Average for Town | 8.5 | 2.4 | 95.02 | 53.08 | 141.99 |
| Phalanges (Toes) | Average All Cases | 2.3 | 00.0 | 27.60 | 16.02 | 35.99 |
| | Open Treatment | 00.0 | 00.0 | 00.00 | 00.00 | 00.00 |
| | S. F. Surgeon Only | 3.0 | 00.00 | 24.00 | 12.58 | 41.29 |
| | Referred before 2 weeks | 3.1 | 00.00 | 27.58 | 17.47 | 10.91 |
| | Referred after 2 weeks | 0.0 | 00.00 | 00.00 | 00.00 | 00.00 |
| | Average for S. F. | 3.0 | 00.00 | 25.42 | 14.27 | 30.77 |
| | City Surgeon Only | 3.1 | 00.00 | 27.97 | 12.03 | 39.04 |
| | Referred before 2 weeks | 0.0 | 00.00 | 00.00 | 00.00 | 00.00 |
| | Referred after 2 weeks | 0.0 | 00.00 | 00.00 | 00.00 | 00.00 |
| | Average for City | 3.1 | 00.00 | 27.97 | 12.03 | 39.04 |
| | Town Physician Only | 3.1 | 00.00 | 28.71 | 20.33 | 36.74 |
| | Referred before 2 weeks | 0.0 | 00.00 | 00.00 | 00.00 | 00.00 |
| | Referred after 2 weeks | 0.0 | 00.00 | 00.00 | 00.00 | 00.00 |
| | Average for Town | 3.1 | 00.00 | 28.71 | 20.33 | 36.74 |
| Humerus | Average All Cases | 26.4 | 9.4 | 421.09 | 226.75 | 474.05 |
| | Open Treatment | 49.2 | 30.2 | 839.59 | 494.84 | 900.97 |
| | S. F. Surgeon Only | 7.1 | 00.0 | 105.37 | 77.33 | 98.39 |
| | Referred before 2 weeks | 62.2 | 45.3 | 1,105.07 | 609.39 | 1,219.41 |
| | Referred after 2 weeks | 00.0 | 00.0 | 000.00 | 000.00 | 000.00 |
| | Average for S. F. | 38.4 | 26.0 | 676.63 | 381.36 | 738.98 |
| | City Surgeon Only | 16.6 | 00.0 | 276.33 | 147.75 | 176.09 |
| | Referred before 2 weeks | 00.0 | 00.0 | 000.00 | 000.00 | 000.00 |
| | Referred after 2 weeks | 00.0 | 00.0 | 000.00 | 000.00 | 000.00 |
| | Average for City | 16.5 | 00.0 | 276.33 | 137.75 | 176.09 |
| | Town Physician Only | 13.0 | 00.0 | 281.74 | 113.00 | 229.79 |
| | Referred before 2 weeks | 22.0 | 00.0 | 320.85 | 197.87 | 388.60 |
| | Referred after 2 weeks | 37.5 | 00.0 | 200.25 | 117.37 | 689.84 |
| | Average for Town | 20.4 | 00.0 | 261.23 | 132.83 | 385.09 |
| Radius | Average All Cases | 6.1 | 00.0 | 50.67 | 41.78 | 90.35 |
| | Open Treatment | 10.0 | 00.0 | 250.75 | 130.50 | 219.34 |
| | S. F. Surgeon Only | 4.3 | 00.0 | 53.39 | 37.54 | 67.46 |
| | Referred before 2 weeks | 6.1 | 00.0 | 85.50 | 60.69 | 85.07 |
| | Referred after 2 weeks | 00.0 | 00.0 | 27.25 | 27.25 | 000.00 |
| | Average for S. F. | 5.2 | 00.0 | 72.64 | 51.74 | 76.05 |
| | City Surgeon Only | 7.2 | 00.0 | 53.53 | 48.16 | 103.18 |
| | Referred before 2 weeks | 6.5 | 00.0 | 67.50 | 52.50 | 105.83 |
| | Referred after 2 weeks | 00.0 | 00.0 | 00.00 | 00.00 | 000.00 |
| | Average for City | 7.0 | 00.0 | 54.05 | 52.03 | 103.28 |
| | Town Physician Only | 6.2 | 0.2 | 39.96 | 34.74 | 90.89 |
| | Referred before 2 weeks | 5.5 | 00.0 | 73.80 | 61.00 | 91.69 |
| | Referred after 2 weeks | 0.0 | 00.0 | 00.00 | 00.00 | 00.00 |
| | Average for Town | 6.2 | 00.0 | 40.46 | 35.13 | 90.90 |

| *Bone* | | *Disability* Temp. | Perm. | *Total* Med. Exp. | *Paid* Doctor | *Comp.* |
|---|---|---|---|---|---|---|
| Radius and Ulna | Average All Cases | 10.6 | 5.5 | $137.56 | $92.36 | $228.66 |
| | Open Treatment | 4.2 | 4.3 | 69.43 | 44.36 | 119.30 |
| | S. F. Surgeon Only | 10.2 | 5.2 | 113.02 | 90.34 | 212.23 |
| | Referred before 2 weeks | 10.4 | 8.0 | 127.32 | 92.62 | 245.66 |
| | Referred after 2 weeks | 22.1 | 0.0 | 99.30 | 67.75 | 424.13 |
| | Average for S. F. | 11.1 | 5.4 | 114.40 | 89.55 | 232.56 |
| | City Surgeon Only | 8.5 | 1.3 | 108.16 | 71.22 | 142.96 |
| | Referred before 2 weeks | 0.0 | 0.0 | 000.00 | 00.00 | 000.00 |
| | Referred after 2 weeks | 13.0 | 0.0 | 650.90 | 345.75 | 249.96 |
| | Average for City | 9.0 | 1.2 | 136.72 | 85.67 | 138.06 |
| | Town Physician Only | 8.4 | 4.5 | 104.12 | 64.23 | 171.61 |
| | Referred before 2 weeks | 48.3 | 66.3 | 615.92 | 460.65 | 1,599.16 |
| | Referred after 2 weeks | 34.3 | 00.0 | 539.90 | 346.40 | 596.64 |
| | Average for Town | 11.6 | 8.3 | 149.72 | 97.82 | 274.11 |
| Ulna | Average All Cases | 8.3 | 00.0 | 80.15 | 62.99 | 139.53 |
| | Open Treatment | 8.2 | 00.0 | 200.13 | 132.88 | 105.67 |
| | S. F. Surgeon Only | 27.2 | 00.0 | 129.83 | 113.18 | 502.43 |
| | Referred before 2 weeks | 14.5 | 00.0 | 197.39 | 185.40 | 228.52 |
| | Referred after 2 weeks | 00.0 | 00.0 | 00.00 | 00.00 | 000.00 |
| | Average S. F. | 18.0 | 00.0 | 165.95 | 127.96 | 317.26 |
| | City Surgeon Only | 8.4 | 00.0 | 46.75 | 32.25 | 157.71 |
| | Referred before 2 weeks | 00.0 | 00.0 | 000.00 | 000.00 | 000.00 |
| | Referred after 2 weeks | 00.0 | 00.0 | 000.00 | 000.00 | 000.00 |
| | Average for City | 8.4 | 00.0 | 46.75 | 32.25 | 157.71 |
| | Town Physician Only | 3.0 | 00.0 | 27.82 | 25.50 | 42.17 |
| | Referred before 2 weeks | 0.0 | 00.0 | 00.00 | 00.00 | 00.00 |
| | Referred after 2 weeks | 5.0 | 00.0 | 140.89 | 88.65 | 74.08 |
| | Average for Town | 3.1 | 00.0 | 36.51 | 30.36 | 44.63 |
| Carpus | Average All Cases | 11.6 | 29.4 | 131.74 | 103.09 | 603.88 |
| | Open Treatment | 9.5 | 66.0 | 224.90 | 172.15 | 1,019.04 |
| | S. F. Surgeon Only | 15.4 | 00.0 | 104.67 | 95.07 | 305.03 |
| | Referred before 2 weeks | 20.5 | 63.3 | 246.01 | 188.22 | 1,328.57 |
| | Referred after 2 weeks | 00.0 | 00.0 | 000.00 | 000.00 | 000.00 |
| | Average S. F. | 19.1 | 42.2 | 198.90 | 157.40 | 987.39 |
| | City Surgeon Only | 4.1 | 00.0 | 38.00 | 28.00 | 38.16 |
| | Referred before 2 weeks | 00.0 | 00.0 | 000.00 | 000.00 | 000.00 |
| | Referred after 2 weeks | 00.0 | 00.0 | 000.00 | 000.00 | 000.00 |
| | Average for City | 4.1 | 00.0 | 38.00 | 28.00 | 38.16 |
| | Town Physician Only | 00.0 | 00.0 | 10.00 | 2.50 | 000.00 |
| | Referred before 2 weeks | 00.0 | 00.0 | 00.00 | 00.00 | 000.00 |
| | Referred after 2 weeks | 00.0 | 00.0 | 00.00 | 00.00 | 000.00 |
| | Average for Town | 00.0 | 00.0 | 10.00 | 2.50 | 000.00 |
| Metacarpus | Average All Cases | 4.1 | 3.0 | 35.51 | 28.29 | 104.21 |
| | Open Treatment | 13.2 | 94.0 | 179.40 | 161.25 | 1,740.88 |
| | S. F. Surgeon Only | 4.1 | 00.0 | 34.98 | 24.95 | 60.77 |
| | Referred before 2 weeks | 4.5 | 00.0 | 28.98 | 22.73 | 66.24 |
| | Referred after 2 weeks | 0.0 | 00.0 | 00.00 | 00.00 | 00.00 |
| | Average for S. F. | 4.2 | 00.0 | 33.65 | 24.46 | 61.99 |
| | City Surgeon Only | 3.2 | 00.0 | 31.73 | 23.56 | 39.90 |
| | Referred before 2 weeks | 0.0 | 00.0 | 00.00 | 00.00 | 00.00 |
| | Referred after 2 weeks | 0.0 | 00.0 | 00.00 | 00.00 | 00.00 |
| | Average for City | 3.2 | 00.0 | 31.76 | 23.52 | 39.90 |
| | Town Physician Only | 5.2 | 11.5 | 44.14 | 40.94 | 264.23 |
| | Referred before 2 weeks | 0.0 | 00.0 | 00.00 | 00.00 | 00.00 |
| | Referred after 2 weeks | 0.0 | 00.0 | 00.00 | 00.00 | 00.00 |
| | Average for Town | 5.2 | 11.5 | 44.14 | 40.94 | 264.23 |

| *Bone* | | *Disability* *Temp.* | *Perm.* | *Total* *Med. Exp.* | *Paid* *Doctor* | *Comp.* |
|---|---|---|---|---|---|---|
| Phalanges (Fingers) | Average All Cases | 4.0 | 1.6 | $42.97 | $33.21 | $78.79 |
| | Open Treatment | 17.6 | 45.3 | 367.46 | 174.02 | 810.66 |
| | S. F. Surgeon Only | 3.3 | 2.3 | 43.02 | 37.62 | 75.62 |
| | Referred before 2 weeks | 5.5 | 17.0 | 85.80 | 37.50 | 141.78 |
| | Referred after 2 weeks | 0.0 | 00.0 | 00.00 | 00.00 | 000.00 |
| | Average for S. F. | 3.3 | 3.0 | 44.32 | 37.59 | 77.67 |
| | City Surgeon Only | 4.2 | 00.0 | 36.71 | 30.07 | 60.64 |
| | Referred before 2 weeks | 0.0 | 00.0 | 00.00 | 00.00 | 00.00 |
| | Referred after 2 weeks | 0.0 | 00.0 | 00.00 | 00.00 | 00.00 |
| | Average for City | 4.2 | 00.0 | 36.71 | 30.07 | 60.64 |
| | Town Physician Only | 3.6 | 2.6 | 46.54 | 31.82 | 94.22 |
| | Referred before 2 weeks | 0.0 | 0.0 | 00.00 | 00.00 | 00.00 |
| | Referred after 2 weeks | 0.0 | 0.0 | 00.00 | 00.00 | 00.00 |
| | Average for Town | 3.6 | 2.6 | 46.54 | 31.82 | 94.22 |
| Skull | Average All Cases | 62.5 | 28.2 | 411.10 | 254.13 | 1,728.24 |
| | Open Treatment | 37.3 | 200.0 | 2,500.00 | 462.72 | 3,440.70 |
| | S. F. Surgeon Only | 6.0 | 00.0 | 87.10 | 35.00 | 104.15 |
| | Referred before 2 weeks | 27.0 | 16.1 | 330.49 | 231.64 | 778.55 |
| | Referred after 2 weeks | 00.0 | 00.0 | 000.00 | 000.00 | 000.00 |
| | Average for S. F. | 25.6 | 13.3 | 289.93 | 198.87 | 666.16 |
| | City Surgeon Only | 44.4 | 40.0 | 305.25 | 190.29 | 1,233.05 |
| | Referred before 2 weeks | 301.3 | 00.0 | 734.37 | 311.60 | 7,089.11 |
| | Referred after 2 weeks | 00.0 | 00.0 | 000.00 | 000.00 | 0,000.00 |
| | Average for City | 108.5 | 30.0 | 287.53 | 220.82 | 2,697.06 |
| | Town Physician Only | 51.3 | 11.6 | 467.17 | 265.03 | 1,256.94 |
| | Referred before 2 weeks | 31.5 | 132.0 | 1,484.30 | 422.73 | 2,386.91 |
| | Referred after 2 weeks | 46.6 | 00.0 | 348.67 | 175.25 | 1,174.92 |
| | Average for Town | 52.2 | 35.6 | 702.66 | 314.10 | 1,590.44 |
| Face | Average All Cases | 3.5 | 00.0 | 133.72 | 86.22 | 49.29 |
| | Open Treatment | 00.0 | 00.0 | 000.00 | 00.00 | 00.00 |
| | S. F. Surgeon Only | 00.0 | 00.0 | 000.00 | 00.00 | 00.00 |
| | Referred before 2 weeks | 00.0 | 00.0 | 000.00 | 00.00 | 000.00 |
| | Referred after 2 weeks | 00.0 | 00.0 | 000.00 | 00.00 | 000.00 |
| | Average for S. F. | 00.0 | 00.0 | 000.00 | 00.00 | 000.00 |
| | City Surgeon Only | 00.0 | 00.0 | 000.00 | 00.00 | 000.00 |
| | Referred before 2 weeks | 00.0 | 00.0 | 000.00 | 00.00 | 000.00 |
| | Referred after 2 weeks | 00.0 | 00.0 | 000.00 | 00.00 | 000.00 |
| | Average for City | 00.0 | 00.0 | 000.00 | 00.00 | 000.00 |
| | Town Physician Only | 3.5 | 00.0 | 133.72 | 86.22 | 49.29 |
| | Referred before 2 weeks | 00.0 | 00.0 | 000.00 | 00.00 | 000.00 |
| | Referred after 2 weeks | 00.0 | 00.0 | 000.00 | 00.00 | 000.00 |
| | Average for Town | 3.5 | 00.0 | 133.72 | 86.22 | 49.29 |
| Vertebrae | Average All Cases | 90.0 | 73.0 | 596.86 | 285.20 | 1,876.66 |
| | Open Treatment | 214.0 | 302.0 | 1,604.67 | 754.62 | 5,465.52 |
| | S. F. Surgeon Only | 97.4 | 00.0 | 591.87 | 322.87 | 1,977.08 |
| | Referred before 2 weeks | 2.2 | 00.0 | 13.00 | 13.00 | 26.78 |
| | Referred after 2 weeks | 84.0 | 00.0 | 539.00 | 379.65 | 1,537.16 |
| | Average for S. F. | 70.4 | 00.0 | 434.16 | 269.60 | 1,379.53 |
| | City Surgeon Only | 39.1 | 12.0 | 584.22 | 246.65 | 873.07 |
| | Referred before 2 weeks | 00.0 | 000.0 | 000.00 | 000.00 | 000.00 |
| | Referred after 2 weeks | 283.0 | 283.0 | 305.82 | 181.50 | 4,999.20 |
| | Average for City | 80.0 | 57.3 | 537.82 | 234.96 | 1,560.76 |
| | Town Physician Only | 00.0 | 00.0 | 000.00 | 000.00 | 000.00 |
| | Referred before 2 weeks | 7.3 | 00.0 | 86.25 | 60.25 | 154.74 |
| | Referred after 2 weeks | 190.0 | 302.0 | 1,354.67 | 579.62 | 4,679.59 |
| | Average for Town | 129.1 | 201.2 | 931.87 | 406.50 | 3,171.31 |

| *Bone* | | *Disability* *Temp.* | *Perm.* | *Total* *Med. Exp.* | *Paid* *Doctor* | *Comp.* |
|---|---|---|---|---|---|---|
| Pelvis | Average All Cases | 35.0 | 13.4 | $550.60 | $179.03 | $738.29 |
| | Open Treatment | 00.0 | 00.0 | 000.00 | 000.00 | 000.00 |
| | S. F. Surgeon Only | 00.0 | 00.0 | 000.00 | 000.00 | 000.00 |
| | Referred before 2 weeks | 4.0 | 00.0 | 122.00 | 64.50 | 44.46 |
| | Referred after 2 weeks | 00.0 | 00.0 | 000.00 | 00.00 | 00.00 |
| | Average for S. F. | 4.0 | 00.0 | 122.00 | 64.50 | 44.46 |
| | City Surgeon Only | 21.4 | 30.3 | 817.37 | 185.18 | 752.77 |
| | Referred before 2 weeks | 00.0 | 00.0 | 000.00 | 000.00 | 000.00 |
| | Referred after 2 weeks | 00.0 | 00.0 | 000.00 | 000.00 | 000.00 |
| | Average for City | 21.4 | 30.3 | 817.37 | 185.18 | 752.77 |
| | Town Physician Only | 73.1 | 00.0 | 463.10 | 223.00 | 1,164.61 |
| | Referred before 2 weeks | 5.4 | 00.0 | 174.59 | 47.00 | 95.22 |
| | Referred after 2 weeks | 00.0 | 00.0 | 000.00 | 000.00 | 000.00 |
| | Average for Town | 56.1 | 00.0 | 390.97 | 179.00 | 897.26 |
| Ribs | Average All Cases | 3.2 | 00.0 | 31.47 | 19.28 | 43.62 |
| | Open Treatment | 7.6 | 00.0 | 130.10 | 73.25 | 137.58 |
| | S. F. Surgeon Only | 2.5 | 00.0 | 26.09 | 17.62 | 35.11 |
| | Referred before 2 weeks | 2.3 | 00.0 | 23.31 | 17.58 | 29.40 |
| | Referred after 2 weeks | 7.0 | 00.0 | 57.20 | 39.00 | 124.98 |
| | Average for S. F. | 3.0 | 00.0 | 27.86 | 19.33 | 38.50 |
| | City Surgeon Only | 4.0 | 00.0 | 34.89 | 20.58 | 55.48 |
| | Referred before 2 weeks | 0.0 | 00.0 | 00.00 | 00.00 | 00.00 |
| | Referred after 2 weeks | 0.0 | 00.0 | 00.00 | 00.00 | 00.00 |
| | Average for City | 4.0 | 00.0 | 34.89 | 20.58 | 55.48 |
| | Town Physician Only | 2.7 | 00.0 | 30.63 | 18.43 | 38.21 |
| | Referred before 2 weeks | 4.0 | 00.0 | 60.34 | 40.37 | 65.06 |
| | Referred after 2 weeks | 0.0 | 00.0 | 00.00 | 00.00 | 00.00 |
| | Average for Town | 2.7 | 00.0 | 30.89 | 18.65 | 38.37 |
| Sternum | Average All Cases | 0.2 | 00.0 | 6.50 | 6.50 | 00.00 |
| | Open Treatment | 0.0 | 00.0 | 00.00 | 00.00 | 00.00 |
| | S. F. Surgeon Only | 0.0 | 00.0 | 00.00 | 00.00 | 00.00 |
| | Referred before 2 weeks | 0.0 | 00.0 | 00.00 | 00.00 | 00.00 |
| | Referred after 2 weeks | 0.0 | 00.0 | 00.00 | 00.00 | 00.00 |
| | Average for S. F. | 0.0 | 00.0 | 00.00 | 00.00 | 00.00 |
| | City Surgeon Only | 0.0 | 00.0 | 00.00 | 00.00 | 00.00 |
| | Referred before 2 weeks | 0.0 | 000.0 | 00.00 | 00.00 | 00.00 |
| | Referred after 2 weeks | 0.0 | 00.0 | 00.00 | 00.00 | 00.00 |
| | Average for City | 0.0 | 00.0 | 00.00 | 00.00 | 00.00 |
| | Town Physician Only | 0.2 | 00.0 | 6.50 | 6.50 | 00.00 |
| | Referred before 2 weeks | 0.0 | 00.0 | 00.00 | 00.00 | 00.00 |
| | Referred after 2 weeks | 0.0 | 00.0 | 00.00 | 00.00 | 00.00 |
| | Average for Town | 0.2 | 00.0 | 6.50 | 6.50 | 00.00 |
| Scapula | Average All Cases | 8.3 | 00.0 | 60.76 | 50.30 | 134.73 |
| | Open Treatment | 0.0 | 00.0 | 00.00 | 00.00 | 000.00 |
| | S. F. Surgeon Only | 8.2 | 00.0 | 71.08 | 62.98 | 150.67 |
| | Referred before 2 weeks | 0.0 | 00.0 | 00.00 | 00.00 | 000.00 |
| | Referred after 2 weeks | 0.0 | 00.0 | 00.00 | 00.00 | 000.00 |
| | Average for S. F. | 8.2 | 00.0 | 71.08 | 62.98 | 150.67 |
| | City Surgeon Only | 12.0 | 00.0 | 92.77 | 68.12 | 208.43 |
| | Referred before 2 weeks | 00.0 | 00.0 | 00.00 | 00.00 | 000.00 |
| | Referred after 2 weeks | 00.0 | 00.0 | 00.00 | 00.00 | 000.00 |
| | Average for City | 12.0 | 00.0 | 92.77 | 68.12 | 208.43 |
| | Town Physician Only | 5.6 | 00.0 | 28.97 | 28.47 | 66.20 |
| | Referred before 2 weeks | 0.0 | 00.0 | 00.00 | 00.00 | 00.00 |
| | Referred after 2 weeks | 0.0 | 00.0 | 00.00 | 00.00 | 00.00 |
| | Average for Town | 5.6 | 00.0 | 28.97 | 28.47 | 66.20 |

| *Bone* | | *Disability* *Temp.* | *Perm.* | *Total Med. Exp.* | *Paid Doctor* | *Comp.* |
|---|---|---|---|---|---|---|
| Clavicle | Average All Cases | 11.5 | 15.1 | $119.53 | $73.01 | $111.69 |
| | Open Treatment | 00.0 | 00.0 | 000.00 | 00.00 | 000.00 |
| | S. F. Surgeon Only | 7.4 | 00.0 | 101.06 | 72.05 | 116.73 |
| | Referred before 2 weeks | 0.0 | 00.0 | 000.00 | 00.00 | 000.00 |
| | Referred after 2 weeks | 0.0 | 00.0 | 000.00 | 00.00 | 000.00 |
| | Average for S. F. | 7.4 | 00.0 | 101.06 | 72.05 | 116.73 |
| | City Surgeon Only | 11.4 | 57.2 | 308.59 | 173.75 | 393.32 |
| | Referred before 2 weeks | 00.0 | 0.00 | 000.00 | 000.00 | 000.00 |
| | Referred after 2 weeks | 00.0 | 00.0 | 000.00 | 000.00 | 000.00 |
| | Average for City | 11.4 | 57.2 | 308.59 | 173.75 | 393.32 |
| | Town Physician Only | 11.5 | 15.1 | 119.53 | 73.01 | 111.69 |
| | Referred before 2 weeks | 00.0 | 00.0 | 000.00 | 00.00 | 000.00 |
| | Referred after 2 weeks | 00.0 | 00.0 | 000.00 | 00.00 | 000.00 |
| | Average for Town | 11.5 | 15.1 | 119.53 | 73.01 | 111.69 |

By comparing the average disability according to whether a specialist or general surgeon was in attendance, we can judge who was the more successful. Of course, we must remember that the specialist was given only the worst cases from the country, so we cannot expect him to have made a good showing with this group. In San Francisco, however, most of the fractures in bones of any importance were treated by a surgeon specially trained in the treatment of fractures throughout, only those patients who refused to be transferred, being left under the care of their own doctors. We should, therefore, expect the specially trained surgeon to excel in the San Francisco group, if his services were more economical.

A claim examiner knows that medical cost will be greater with a specialist in attendance than with a surgeon, or general practitioner. The specialist is trained to use the accessories of medical science with far greater frequency. X-rays will be more freely used. Teeth, tonsils, prostates and other foci of infection will be cleared up, with their addition to expense. Consultation and laboratory costs will increase. The fact that the patient is away from home leads to longer hospitalization with the attendant dangers of traumatic neurosis. For the same reason he cannot return to work until treatment is completed.

Unless the specialist reduces the period of disability or the degree of permanent disability, how can one justify his use?

## CLASSIFICATION OF INJURIES

To determine which patient should be brought to the city, a claim examiner must classify all injuries into serious, intermediate and minor. He knows that the serious fracture, such as one of the femur, must be dealt with at once by a fracture specialist. Then we have the group of lesser fractures, such as the fingers and toes, which are usually left under the care of the general practitioner. Between these two extremes falls the great group of intermediate fractures that may be handled in either way. It is easy to convince the patient and his friends, the employer and the doctor that a fracture of the skull needs the services of a specialist. It is

not so clear that a fracture of the radius should be sent fifty or a hundred miles from home.

Patients cling faithfully to their own medical advisers. They often feel that their doctors are thoroughly competent to treat any and all types of injuries, regardless of severity. They do not wish to leave their homes to go to the city. The attending doctor often feels that a slight is placed upon his ability, when it is suggested that another might care for the patient better than he. To transfer every patient would be foolish; to transfer none, equally illogical.

Probably no problem is more difficult to the claim examiner than to determine whether this particular patient should be transferred to a specialist or not. He has nothing at hand but the doctor's reports, which are often very meager and the patient is usually miles away. He may talk by 'phone to the doctor, who frequently minimizes the situation, because of the optimism inherent in the medical profession. But he must choose, and on his choice rests the credit or blame. It is no easy task.

If we clearly knew which types of injury would be most economically treated by a surgeon especially trained in the treatment of fractures, these cases would be brought to the city. Those of insufficient importance should be left under the care of their home doctors. This tabulation was made in order to determine these classes. Unless the specialist reduces the period of disability with a given group, how can one justify his services?

## FRACTURES OF THE FEMUR

To determine this point, let us first examine the record of a serious fracture such as a fracture of the femur. You will note that the average period of disability was fifty-four weeks, with a permanent disability equal to fifty-seven weeks of wages. This is a tremendous loss. The average cost was $1,148.00 compensation and $795.00 medical, a total of $1,943.00. When you consider that every femoral fracture is going to cost the patient more than one year in time, and the company nearly $2,000.00, such cases are truly worthy of real study.

Did the country patient, or the city patient fare better? As one might expect, the country disability was nearly three times the city disability, and over four times the San Francisco disability. In the country group, the disability was twelve times greater when the patient was not referred to a specially trained surgeon until more than two weeks had gone by. In other words, if the specialist saw the patient in less than two weeks from accident, he saved many, many weeks.

It is, therefore, obvious that no delay should be allowed, if a case is to be transferred.

## FRACTURES OF FINGERS

In the bones of lesser importance, the fracture specialist has not made a very good showing. The period of disability with fracture of the fingers has been greater under his care than with the general surgeon.

In fact, the country doctor was the most efficient. Of course, this is easy to understand. A specialist is cautious. He is trained to expect trouble. He but rarely treats so minor an injury as a fractured finger, and will not risk letting the patient resume duty too soon. We see that these patients took nearly six weeks to resume duty, when treated by the specially trained surgeon. Such patients worked in four weeks when treated by the general surgeon. The specialist produced a doubling of medical cost, without reducing disability.

### METATARSUS AND METACARPUS

Claim examiners often feel that fractures of the metatarsus are of no great importance, but this is not true. The general surgeon developed a period of disability of eight weeks, whereas the fracture specialist returned his men to work in a little over five. The surgeon's medical cost was $73.00 against the specialist's $41.00, if he saw the patient before two weeks. The surgeon who is specially trained in the treatment of fractures excelled in his treatment of these patients, because the general surgeon does not fear a fracture of the metatarsus in sufficient degree. The bone and joint surgeon at once has in mind the danger of disturbances in the mechanism of the foot, so he gives more care and thought to these patients.

We have a very similar situation with the metacarpus. Both returned their men to work in between four and five weeks. However, the specialist produced a medical cost of only $29.00 against $37.00 for the surgeon. These seem like very small differences to worry about, but fractures of the metacarpus, because of their great number, when taken together cost more than one-fourth as much as all our cases of fracture of the femur. Therefore, if the specially trained surgeon can save us practically twenty-eight per cent. of our medical cost in fractures of the metacarpus, a real sum is saved at the end of the year. One would be justified in considering that fractures of the metatarsal and metacarpal bones are best treated by the surgeon specially trained for this work.

### OPEN FIXATION OF FRACTURES

The added cost and disability with open fixation is well brought out in fractures of the humerus. Fifty-six per cent. of the San Francisco cases were operated upon, while only eleven per cent. of the town cases were similarly treated. It is therefore not surprising that the average disability was greater in San Francisco.

Fractures of both the tibia and fibula together show a high operative proportion of forty per cent. Only two-thirds of these operations were done by bone and joint surgeons. This probably accounts for the fact that the disability was much worse in the country group.

In reviewing many files, it seems clear that some doctors lean toward open methods. It is tempting to fix the fragments once for all, but this

procedure is not without its dangers. It is exceedingly embarrassing to have an infection develop after opening a simple fracture. This happens far too often, even with surgeons who are very careful of their technique. They usually know but little about what goes on in the operating room when they are absent. In doing bone surgery, they should make it their duty to ferret out the cause of every infection, if possible, because the operating room staff may undo the surgeon's most careful work. It is questionable if open bone surgery should ever be done except by highly trained men, with highly trained assistants, in highly trained hospitals; otherwise disaster is likely to result.

### FRACTURED RADIUS AND ULNA

Now we come to the great intermediate group of fractures, which are either treated by a fracture specialist, or a general surgeon, depending upon the severity of the individual case. With the radius and ulna combined, the general surgeon made as good a record as the specially trained surgeon.

In the treatment of these bones separately, the general surgeon closed his treatment even sooner. In San Francisco most of the fractures of the radius were treated by a fracture specialist from the start, with an average disability of six weeks. The country surgeon obtained as good a result with less than half the medical cost.

This is generally true throughout the fractures of intermediate importance. Thus one is forced to the conclusion that the specialist does not always reduce disability, even with the added cost of his services. When one reviews the individual files, the reason is clear. The general surgeon or practitioner is closer to the human side of the practice of medicine. He subconsciously is always trying hard to relieve his patients of expense, though he sometimes uses too few of the accessories of medical science, or discharges the patient from treatment too early. It is not at all rare that a general surgeon treats a fracture throughout without even taking an x-ray picture. Such a procedure is obviously fraught with danger. The fracture specialist goes to the other extreme. He considers his patients' welfare without regard for time and money. He therefore has but few recurrences. His patients usually stay at work when he sends them there. But sometimes he goes too far, and in average groups of less important fractures, the general surgeon conserves more time and money than the specially trained surgeon.

As so frequently occurs with groups of people approaching the same problem from two different directions, most of them sometimes go too far. It would seem that perhaps the general surgeon should use more of the accessories of medicine, especially in his more serious cases and that the specialist might dispense with some items of cost, especially in cases of minor magnitude. Again, the general surgeon frequently permits the patient to resume duty too soon, with resultant recurrences, whereas the

specially trained surgeon pays much less attention to the date the patient should resume duty. Probably the specialist should consider this subject of more importance, making an effort to return his patient to work at as early a date as is safe.

## CONCLUSIONS

In conclusion our tabulation shows that the surgeon who has been specially trained in the treatment of fractures produces far better results in serious fractures, but that the general surgeon does more efficient work with minor fractures. In major fractures, the added cost produced by the specially trained surgeon is more than compensated by decreased disability. This is not true in minor fractures.

Let me, therefore, plead that your care and caution, born of your training and specialization, should always be tempered with good, practical judgment, to prevent any unnecessary treatment or loss of your patient's time.

## DISCUSSION

NOTE: Various points brought out in the discussion of this paper at the meeting are summed up in Dr. Gray's closing discussion which follows.—*Editor.*

DR. ROSCOE N. GRAY, San Francisco, Calif. (Closing): There were so many points brought up in the discussion that I think I had better limit myself to the specific questions.

Answering the first question of Dr. Wallace relative to whether an equal number of all kinds of fractures went into these statistics, I would say that this was not true. What we did was to take all the cases that were reported originally as fractures. They were all coded. In the fractures of the vertebrae, for example, there were very few cases as compared with fractures of the ribs. We are only quoting cases that were originally diagnosed as fractures, because our code is made from the original report. If a doctor made a mistake, the diagnosis card was not changed. Now we are going through our files to find those cases that were diagnosed incorrectly and another table will be made.

Relative to the point brought out by Dr. Albee regarding the therapeutic workshop, there has been a good deal of experimentation in one part of the country or another with this work. We have tried it in San Francisco. Dr. Cleary did a great deal of it after the War, based on lessons learned in the Army. It was tried in the State of New York where a therapeutic laboratory was carried on in Syracuse, but the factor which has caused the failure of so many of them is that they are run by improperly trained persons. There are apparently not enough doctors or physiotherapists who are properly trained to do rehabilitation work to have it of exceedingly great value from a therapeutic point of view.

Dr. Dickson's point about not wanting "wrecks" is certainly true. When a fracture of the femur comes to the specially trained surgeon after the damage has been done and he is asked to repair that "wreck", all that he can do is to do his best, which will not be very good.

As to Dr. Stoddard's point that hospital rates are cheaper in the country than in the city, he probably misspoke. In California the hospital rates are higher in the country than in the city; in this table there are two columns, one labeled "doctor's cost", that is, the fee paid to the doctor, and the other "medical cost", which includes every kind of medical cost, including anaesthetic, operating room, dressings, etc.

Dr. Cleary's point relative to data hidden away in the company's files, to me is the most important part of the whole subject. If you walk into the office of a life insurance company and ask for statistics they can give you all sorts of figures from the medical life insurance point of view. If you ask a casualty company the simple question of what proportion of patients have fractures and the kind of treatment used, they cannot answer. They cannot answer any question from the medical point of view, from their experience.

I suppose if an Association like yours would ask the home office for such statistics, they would try to fulfil your request. At least this study was made at the request of your Association.

# THE ARTICULAR MECHANISM OF THE DIARTHROSES*

BY THOMAS WALMSLEY, BELFAST, IRELAND

*Professor of Anatomy, Queen's University*

The functions which are required at the diarthroses are, (1) the transmission of weight through a temporarily stabilized couple, the components of which are displaceable, and (2) the free movement of the components on one another by the action of the related muscles. The former of these functions is also served at the synarthroses, but in them the surfaces of the components are so formed and are so related that they are not displaceable *on* one another; those movements which do occur at them are not obtained by the free movement of the surfaces *on* one another but by their forcible separation, or closer apposition, through the action of other forces than the surrounding muscles and they occur in either direction from the normal position of stability.† The transmission of weight, then, as the main function of a joint, is satisfactorily accomplished by a synarthrodial formation, or by such an approximation to it of a diarthrosis as is found at the sacro-iliac junction‡; but if the function of voluntary muscular movement is also to be present there must be such formations of the joint surfaces as will permit them to be moved on one another from the position of stability, in which, it may *a priori* be expected, they are in maximal congruence, and to assume other relations to each other than those which obtain between them while they are weight-transmitting junctions. That is, during the movement a new area of the one surface is brought into contact with the same area of the other surface; and it is the essential problem of the mechanism of the diarthroses to resolve the nature of the new contact, whether it be like that in an artificial joint, always maximal, or whether it be not so.

There are then at the majority of the diarthroses two functions equally to be served: (1) the function of weight transmission which is accomplished in one position, and one position alone, and to secure which there are the articular mechanisms; and (2) the function of movement, during which the surfaces of the elements are moved on one another and maintained in their

*A lecture delivered to the British Orthopaedic Association at the Annual Meeting in Belfast, May 1927.

†At the inferior tibiofibular junction, for example, medial and lateral displacements of the lateral malleolus occur in plantar-flexion and dorsiflexion of the foot; they are produced by the movements of the talus and by the action of the posterior talofibular ligament.

‡There is, in normal conditions and apart from pregnancy and parturition, extremely little movement of the pelvic joints, there being but a slight play, induced by the weight of the body and limited by the sacral ligaments, at the sacro-iliac joints. It is of considerable interest to note that the articular cartilages at these joints are largely fibrous; and, of course, especially in advanced life, the surfaces are rough and irregular.

relations to one another by the mechanisms of movement, which are the related muscles. Each function has its own mechanism.

The function of movement is served by the muscles; they move the joint surfaces on one another and they retain them in contact, as far as their reciprocal formation will allow, during movement, but they do not act while the joint is a weight-transmitting mechanism. At such a joint as the shoulder joint in man, for example, where movement is the main function, there are, I believe, no articular mechanisms which would secure a position of stability for the transmission of weight, though my first master in anatomy, the late Professor Cleland, believed that there was the remnant of such a mechanism in the notch in the anterior edge of the glenoid fossa[1]; but there is a special group of muscles, which, following Winslow[2], I have in another place[3] suggested should be named the *articular muscles*, which act, not in effecting movement at the joint, but to secure the conditions necessary for the effectors of movement to act and in the absence of whose action normal movement cannot take place.*

The articular mechanisms are those which bring the joint surfaces into that one relationship with each other in which they can transmit weight and which retain them in that relationship without the active contraction of muscles; which transform them, in the functional sense, from diarthroses to synarthroses. They are inactive during the function of movement; but they continue to act in a joint preparation from which all the muscles have been removed when the elements of the joint are moved on one another by hand.

The primary movements of the hip joint, which is the joint I have selected to explain these views, are the movements of flexion from the extended position and the movement of extension back to this position. In these movements, as usually performed, there are secondary accompaniments which can be expressed as abduction and adduction and lateral and medial rotation of the thigh, but which, though secondary movements, may be performed in certain positions of the joint as unusual and uncommon primary movements. As would follow from what I have already stated, there is no articular limitation of the movement of flexion. This movement is limited by factors entirely adventitious to the joint, such as contact between neighbouring parts, or the ligamentous action of muscles, or the insufficiency of the muscles further to contract; and, as would be expected, the position of limitation is extremely different in different people and can be markedly altered by suitable training. There are now on these points numerous records of all the diarthroses in the body. The movement of extension, on the other hand, has a definite position of limitation, a position which is remarkably uniform in all classes of people and which cannot be altered by training; which is unaffected by the presence or absence of the surrounding muscles, for it is the same in an entire joint

*These muscles are the supraspinatus, infraspinatus, and subscapularis, which in addition to their ligamentous action, however, may take part in the rotary movements of the humerus.

and in one from which the muscles have been removed; and which is induced and maintained by the articular mechanisms.

There are two articular mechanisms. The first is the inelastic, non-contractile, fibrous capsule, the ligamentous parts of which are taut, and therefore functional, in only one position of the joint, that in which it transmits weight, and in all other positions within the normal range are slack so that in regard to them the joint surfaces can be separated from one another; at the hip joint in seventy degrees of flexion, five degrees of abduction, and ten degrees of lateral rotation, the capsule is most slack, the intra-acetabular and extra-acetabular parts of the joint cavity will hold the maximal amount of injection fluid, and the head of the femur can be separated two centimeters from the acetabulum. The second is the peculiar but definite shape of the articular surfaces themselves above and beyond the modifying influences of the articular cartilage.

The former of these mechanisms is of course very evident in its action, but it would be peculiarly ineffective, unless it were extremely complicated in the arrangement of its bands, if the joint surfaces were perfectly reciprocal in their shape and of a regular mathematical form; and at a hinge joint, with only collateral ligaments, it would not act at all unless a receiving (or female) surface of lesser radius of curvature is continuously being fitted by a (male) surface of greater radius of curvature until the two are congruent. At the hip joint as the limb moves towards extension, and materially assisted by the anterior inclination of the neck of the femur, the capsule is progressively twisted and shortened, and, as it were, guides the head of the bone like a screw into its socket until at the position of full extension (about fifteen degrees beyond the vertical) the capsule is taut, the head of the bone is screwed home, the surfaces are fully congruent, and further movement of a larger on to a smaller surface is impossible.

This aspect of joint mechanism—the definite and non-reciprocal shape of the joint surfaces which determines that they are in full congruence only in the positions in which they transmit weight and are incongruent in all other positions—has not always been taken into account in descriptions of joint function and, in fact, is by no means universally admitted. Fick[4] and Strasser[5] do not include it in their descriptions, and in the references they make to it they maintain that the elasticity of the articular cartilage is such that any departure from the regular form will be equalized by pressure; neither even refers to Goodsir's[6] work on the ultimate form of joint surfaces and neither makes mention of the important functional deduction he made, that in their movements joint surfaces are in part in action and in part at rest. It has been demonstrated, however, at the knee (Bruce Young)[7], at the atlanto-axial joints (Fick)[4], and at the elbow (Hultkrantz)[8]; and it may be shown at the hip joint in the following preparations.

(a) The femur should be sawn off about six inches below the great trochanter and the capsule of the hip joint and the innominate bone cleaned all round. A section should then be cut through the hip joint as near as possible parallel to, and slightly more medial than, the line between the

centre of the head of the femur and the centre of the knee joint, that is, at right angles to the axis of rotation of the head in flexion and extension movements; the capsule should be maintained entire. On the face of the section it can be seen that the margin of the femoral head is in full congruence with the acetabulum in extension, but that in the flexed joint, and even with pressure applied to keep the bones in contact, part of the head is separated from the socket by a narrow space.

(b) Plaster-of-Paris casts are made of the fresh joint surfaces. On the cast of the acetabulum the position of the acetabular notch is marked, and then the surface is scraped away until the head of the femur can be inserted in the socket. It will be found that in the position of flexion the head lies easily in the socket and that it can be rotated to the position of extension; but that at the position of extension the surfaces lock one another and further rotation in this direction is impossible without withdrawing the femoral head.

It comes to this, then, I believe: that the joint surfaces of an organic combination, unlike those of an artificial joint, are not in total contact with each other except in the one position of weight transmission; that in the movement from this position, which is in one direction only, except perhaps at some of the finger joints*, the surfaces are unlocked from their congruence and are only in part in contact, for in part they are free from contact, with potential spaces between them, and at rest; that in movement towards this position the joint surfaces are not only rotated on one another but there is also linear advancement of one area on the other, so that the centre of rotation and axis of rotation are always changing; and that this movement is continued until the surfaces are fully congruent and further movement in this direction is impossible without damage to the surfaces.

The hip joint is, then, as other joints have been shown to be, a screw joint, the head of the femur being screwed home in extension and unscrewed, and emerging from the acetabulum, in flexion; and the cotyloid ligament is unossified to allow it to do so†. This lateral movement of the femoral head from the acetabulum is difficult to measure, and I am not yet satisfied that I have measured it; but, if it does occur as I have said, it will produce a potential apical space between the head of the femur and the acetabulum, in addition to the potential spaces between the surfaces. The latter spaces are occupied by the synovial fluid which is thus circulated throughout the joint cavity; but the apical space is occupied by the fat of the haversian pad in the acetabular fossa, and the extra material which is required is drawn into the acetabular cavity through the acetabular notch under the transverse ligament. Any joint preparation will show this movement of the extra-acetabular fat into the joint in flexion and its extrusion from the joint in extension.

*At the metacarpophalangeal joints the collateral ligaments are stretched in the flexed position; this explains the absence of the movements of abduction and adduction of the fingers in this position. At the thumb the joint is of a different kind.

†The cotyloid ligament is not considered, therefore, to deepen the acetabulum but to make it more shallow.

The head of the femur, then, is not perfectly spherical. This was stated first by Aeby[9] as long ago as 1863 when he described it as a rotational ellipsoid of which the greater axis lies horizontally; that is, that the radius of curvature of the meridian is greater then the radius of curvature of the equator. Some years later, in 1874, Schmidt[10], working under Aeby and using a method of reconstruction from sections of fresh cartilage-covered bones, gave as the average measurement, in the male, of the radius of curvature of the horizontal meridian twenty-six and five-tenths millimeters and of the radius of curvature of the equator twenty-four and eight-tenths millimeters; and somewhat similar figures, though expressing a smaller difference, were given by Helwig[11] in 1912. My own figures also express this difference, but they further show that the curvatures of different meridians are different[12]. It is of some interest to note that in the ox and the sheep, where the movements at the hip joint are more strictly confined to the sagittal plane than in man, the difference between these measurements is greater*; but it is of greater interest to record that in the human foetus and in the first and second years of life the difference between the curvatures is reversed. At birth the radius of curvature of the meridian is six millimeters and of the equator six and seven-tenths millimeters, so that the head is flatter; in late foetal life the proportional difference is greater, but in a three-year-old boy the curvatures are equal. The transmission of the weight may be the retarding influence of the growth in the plane at right angles to the axis of movements of flexion and extension.

There are similar changes in the acetabulum.

These changes of the articular surfaces are acquired changes; they occur to different amounts in different individuals†; and they are, I have attempted to show, part of the mechanism of the joint.

*The proportion in man may be as great as 1:1.09; in the ox the proportion is 1:1.22; in the sheep 1:1.39. (Strasser[5] III, 88.)

†The femoral heads are of the same shape in the one subject, but there are differences in the amount of departure from the spherical form in different subjects.

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# SOME CONSIDERATIONS OF SECOND TYPE ARTHRITIS AS EXEMPLIFIED IN THE SHOULDER JOINT*

BY ARTHUR L. FISHER, M.D., SAN FRANCISCO, CALIF.

The term "Second Type Arthritis", Ely's classification, is used in this paper not only from habit but because it is non-committal. By it is meant that type of arthritis usually spoken of as hypertrophic in the United States, as osteo-arthritis in England and as arthritis deformans in Germany. It is not the intention of the author to give a complete account of arthritis but rather to dwell upon a few suggestive facts in the hope of stimulating further observation on the one hand and friendly criticism on the other.

The writer does not contend that he can establish perfect proof, but does maintain that the points he endeavors to bring out are suggestive and well worth investigation. He wishes his position to be understood clearly. That which follows will not fulfil Koch's postulates, but if it will stimulate even a little work towards fulfilling those postulates, it is well worth while. Not many years ago Osler said concerning chronic arthritis,—that it still remains a reproach to the profession. The problems in connection with this disease are difficult but they are not unsolvable. It is, to use a slang expression, up to us, to us orthopaedic surgeons who probably have more to do with this disease than any other branch of the profession, to do our share in the solving of the problem.

When one studies the histology of this disease, one is struck by an outstanding fact,—and yet this outstanding fact is not sufficiently emphasized in the ordinary accounts of the disease.

The one most striking phenomenon in second type arthritis is the death of bone and marrow. As we look over sections of such a joint we find areas of dead bone in which the nuclear elements have disappeared, or have faded; toward the periphery of such an area there may be an infiltration of round cells; and beyond this an area of new bone formation. In other spots the area of dead bone is all that is seen and in still other spots cavities are found. Death of bone is the initial and consequently the most constant pathological finding. These lesions begin really as focal necroses and all the subsequent changes,—the ones that so frequently dominate the x-ray picture,—are secondary and follow as response by the tissues to the irritant that produces the necrosis.

The response of the tissues to an irritant produces the process known as inflammation; qualitatively the response to all irritants is the same, quantitatively it is very different. It is not the purpose of the author here

*Read before the meeting of the American Orthopaedic Association, Yosemite Valley, California, June 1927.

to deal with the process of inflammation as it is applied to bone, but merely to point out the essential fact that tissue responses are all similar, varying one from the other only in regard to the quantity of cells of one kind or another that may be present,—in other words, to the predominance of a given type of cell, or the predominance of a given part of the inflammatory reaction. It is this predominance of a part of the process that makes the difference between an abscess on the one hand and a proliferative inflammation on the other. All parts of the inflammatory process are present in each type of lesion but the predominance of polymorphonuclear leucocytes makes the type called an abscess and the predominance of the changes in fixed tissue cells dominates the picture in a proliferative inflammation, though all types of change are present in both lesions.

The shoulder joint has been selected because it illustrates perhaps better than any other joint in the body the basic fact that it is the death of bone that is the earliest *demonstrable* lesion in second type arthritis.

The clinical manifestations are usually those of the group of conditions frequently classed together without differential diagnosis as stiff and painful shoulders. The principal signs and symptoms are pain about the shoulder that may radiate down the arm, and limitation of motion,—abduction, internal and external rotation. Tenderness may or may not be present. Atrophy of the muscles about the shoulder will be dependent upon the length of time the disability, rather than the lesion, has existed. In brief, that is the clinical picture. But it is also the clinical picture of numerous other entities. But details of differential diagnosis do not interest us for the moment. It is the consideration of the arthritic lesion in the shoulder joint itself.

Assuming for the moment the correctness of the dogmatic statement

FIG. 1

Second type arthritis of hip showing cavity formation.

FIG. 2

Second type arthritis showing cavity formation, new bone in capsule.

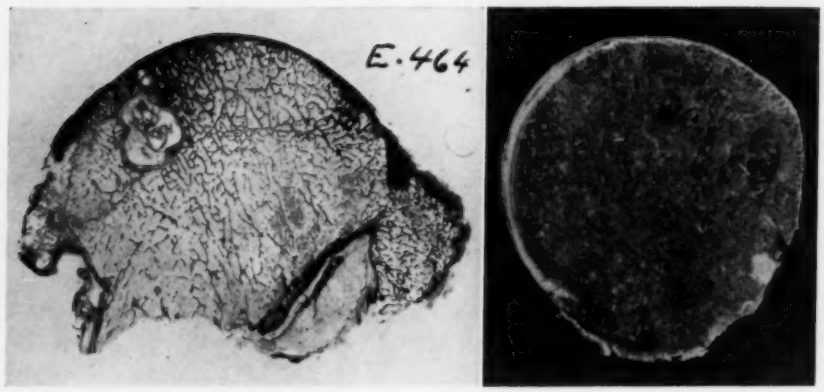


FIG. 3 FIG. 4

Section of humerus showing cavity formation.

that the most striking thing about second type arthritis is the death of bone; how does such death occur? What is it that produces the death of bone in irregular foci with healthy bone between them?

Let us compare for a moment some other types of lesion characterized by focal necroses. In typhoid infection focal necroses appear in the liver, for instance. In these necroses typhoid bacilli can always be found. They produce the necrosis and around the necrosis there is a tissue reaction. In typhoid lesions the earliest experimental lesions show a wandering out of leucocytes and the more characteristic reaction of the tissues follows this. In the formation of a tubercle much the same process takes place. Wechsberg, in 1900, showed that the earliest lesion in the formation of a tubercle is the wandering out of polymorphonuclear leucocytes, and the characteristic structure of the tubercle follows this initial change. In an ordinary abscess it is the wandering out of the leucocytes that is the main portion of the lesion and the tissue reactions are comparatively slight though present. One other lesion should be considered especially, because the bone reaction is so similar to that of second type arthritis. This lesion is osteoplastic carcinoma. In the ordinary carcinoma of bone there is bone destruction predominating with little or no bone production going on, but in the rarer type of bone-producing carcinoma, usually from a primary prostatic growth, death of bone tissue takes place and around the dead bone quantities of new bone are formed. In this condition the living carcinoma cells seem to be the irritant that produces the reaction.

Now, in second type arthritis what is it that produces the irritation of the tissue? We can demonstrate the dead bone, often with cavity formation. We cannot, however, demonstrate bacteria as in typhoid, pyogenic or tuberculous infection, nor can we demonstrate tumor cells as in osteoplastic carcinoma.

We believe, however, that another type of living cell can be demonstrated. It is in the cavities that occur in the dead bone that Professor

FIG. 5
Cavity formation in head of humerus. Second type arthritis.

FIG. 6
Cavity formation in head of humerus. Second type arthritis.

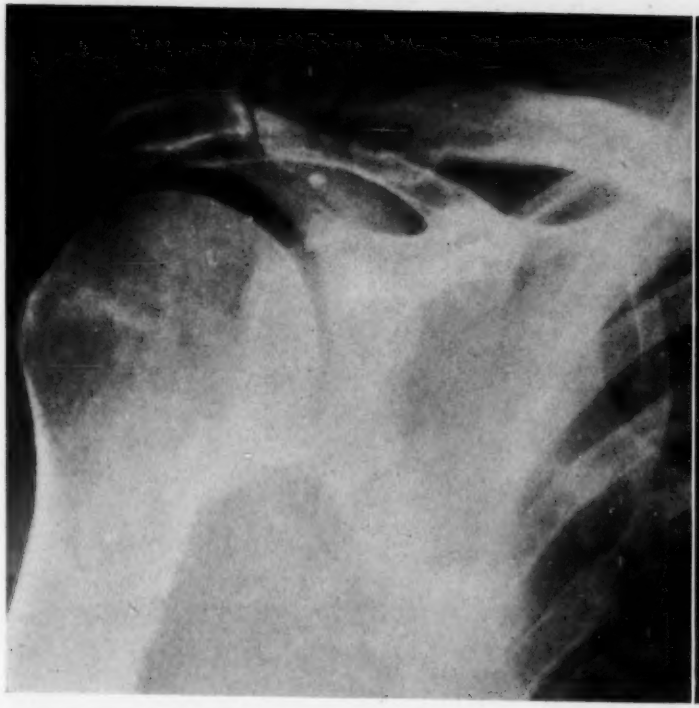

FIG. 7
Cavity formation in head of humerus. Second type arthritis.

FIG. 8
Cavity formation in head of humerus. Second type arthritis.

FIG. 9
Cavity formation in head of humerus. Second type arthritis.

FIG. 10
Cavity formation in head of humerus. Second type arthritis.

FIG. 11
Cavity formation in head of humerus. Second type arthritis.

Kofoid, of the University of California, an authority on amoebae, believes that he has demonstrated amoebae in the tissues. It is true that they have not been demonstrated frequently, but it is also true that the identification of amoebae in the tissues is still a matter of technical difficulty. Is there any other evidence of amoebic origin of second type arthritis? Only indirect. Here in California an examination of the stools of a cross section of the population would show about twenty per cent. of amoebic infestation. In arthritic patients one can demonstrate amoebic infestation in about sixty per cent. of the cases in a routine examination of five stools,—and probably in a larger percentage if one examined for a longer period of time, as evidenced by the fact that in one case they were found on the fourteenth examination and in another after some twenty-odd examinations. A further bit of evidence is that with the administration of emetin a greater proportion of chronic arthritics get relief and amelioration of symptoms than by any other method of treatment used in an experience of twenty years. When Dr. Ely started using emetin to kill the amoebae in arthritics, no one could have been more skeptical as to its value than the author. But with the lapse of time and the observation of good results, he has been converted from a skeptic to an advocate.

In brief, then, these are the findings with regard to the amoeba:

1. Presence of amoebae in the stools in a large proportion of arthritics.
2. Probable demonstration of amoebae in the characteristic lesions.
3. Improvement of patients with emetin administration.

Now, with reference to the shoulder, a patient presents himself with the characteristic symptoms and signs of a stiff and painful shoulder. One of the constituent members of this group of conditions is surely chronic arthritis. As an aid to diagnosis an x-ray picture is made. Such an x-ray may show the ordinary picture of second type arthritis with its bony fringes, but most commonly it does not. It merely shows cavity formation in the bone in the head of the humerus. These holes are seen as areas of lessened density, spherical or spheroid in shape, often with an area of greater density about them. In most cases this is all that is seen, for in most cases, for some unknown reason, the hypertrophic nodules of so called hypertrophic arthritis are not seen. A not inconsiderable proportion of these cases will show typical hypertrophic changes at the acromioclavicular joint.

On what grounds are we justified in saying that the death of bone precedes the nodule formation?

First, we find it about the shoulder joint without nodule formation. In the second place, we see it in other joints,—the hip, for instance,— as a constant, not an occasional, finding, and, on studying sections of the joint, we find dead areas without any corresponding hypertrophic nodules, as well as those with hypertrophic nodules. Third, by comparison with other lesions we find that a living irritant acting over a period of time produces, first, death of tissue and then reaction about the dead area. We believe, therefore, that all cases of second type arthritis are due to a living organism.

## DISCUSSION

Dr. John L. Porter, Chicago, Ill.: I cannot help feeling that the title which the Doctor has chosen for his paper is unfortunate. When I saw the title on the program "Type II" meant nothing to me, and I am sure that to a large percentage of the members it carried no definite meaning. Moreover, the terminology of chronic arthritis is burdened with so much unnecessary matter, in the way of new names, etc., that it seems unwise to add more. Another thing, in looking up the literature on arthritis the medical profession is so accustomed to the common terms of "rheumatoid arthritis", "atrophic arthritis", "hypertrophic arthritis", etc., that new names like "Type II" might easily be ignored or overlooked unless the investigator knew just what the author intended by that designation; and, furthermore, the names "osteo-", "hypertrophic" and "infectious" arthritis have come to be so well established in our literature as illustrating the three well defined clinical types that we find they are sufficient for our purpose; and they are practical, as they indicate the pathology.

The Doctor's paper is very encouraging and in some ways startling. It encourages us to hope, and I am glad to hear that he says in his paper he wants to merely stimulate us to further study and enthusiasm. It may stimulate us to find the cause for hypertrophic arthritis, if not for the atrophic type. Those of us who have come in contact with a large number of cases of arthritis have felt for a long time that the intestinal tract is a frequent source of infection. No one has been able to demonstrate which of the

bacterial flora it is that causes the condition. The Doctor's statement that sixty per cent. of the cases of osteo-arthritis, which have had five faeces investigated, show infection with the amoeba, is rather startling because the amoeba is hard to identify and has seemed to be only occasionally found in the faeces outside of California, so far. May be there is a special variety of amoeba that is indigenous to the soil of California that accounts for such a high infestation.

I wish to remind you of one thing, and that is, that all the changes seen in hypertrophic type of arthritis, particularly in such conditions as are found in the shoulder, can be brought about by circulatory changes alone. That is suggested by the fact that while we see atrophic arthritis in young adults, hypertrophic arthritis is seen more frequently past middle age. If the circulation in the shoulder joint is sufficiently impeded by a lack of elasticity or degeneration in the blood vessels, there is no reason why atrophy and absorption, or even cavity formation, might not take place.

Dr. R. B. Osgood, Boston, Mass.: One thing which interested me very much in Dr. Fisher's paper is his conviction evidently that second type arthritis is of infectious origin. With that he agrees with Timbrell Fisher and various other workers. But I hark back to the orginal investigations of Nichols and Richardson in which absence of small round-cell infiltration in most cases of type II or osteo-arthritis is the thing which even Timbrell Fisher admits is the rule. I feel that you may have an osteo-arthritis in which there is no small round-cell infiltration and yet produce typical subjective symptoms and show typical gross pathology. Consequently, I should hesitate to use the term infectious because many of us in the East look upon them as being degenerative without infection or as traumatic without infection. Now the question is, where the disease begins. Dr. Fisher may have obtained many early cases. It may be quite right that it does begin in the bone marrow just as we find that tuberculosis usually begins there; Nichols and Richardson in their large series thought it could not begin in the bone marrow. They recognized these cavities but they thought the earliest changes were in the articular cartilage. If you watch these cases roentgenologically, you will see rarefied areas in the bone ends appear which we have attributed to the atrophy of non-use alone.

The question of amoeba I am sure Dr. Ely and Dr. Fisher can tell us more about than any one else. The important thing is to find out what is the essential causative factor. If it can be found, of course a tremendous advance will have been made. We ought to look for it very hopefully. Our pathologists have been trying to find it for a long time but they have not succeeded, yet type II arthritis is a very common disease. I question whether the cavities seen in the shoulder joint are typical of this condition because I find these appearances in very many other cases. We find these appearances in cases where the shoulder has been tied up and where an old bursitis has been present and where treatment directed to that cause relieves the condition without any evidence of type II arthritis anywhere else. Also, the acromioclavicular joint will show many changes in these people without there being any changes in the shoulder joint. We know that this condition occurs in the young as well as in the old.

Emetin interests me very much. I have been entirely skeptical until Dr. Fisher told me about it. Recently one of the men from the East has been out here and has become convinced that emetin does good. Emetin has certain dangers and it must be administered with care, as Dr. Ely and Dr. Fisher have pointed out.

In the East we do not look upon type II arthritis as usually presenting any serious problem as far as relief of symptoms is concerned, except where the hip joint is involved. If you protect the joints they seem to recover, with the one exception of the hip joint. That is exceptionally difficult of relief. With rest the symptoms quiet down and the pain disappears. I am delighted that Dr. Fisher presented this subject. It is just the sort of a report we should have on the basis of real work done.

Dr. Leonard W. Ely, San Francisco, Calif.: I always hesitate to talk on this subject, because I never know when to stop. It is a strange thing that when the subject of chronic arthritis is brought up at a medical meeting some one of the audience almost

invariably regards something about it as a joke. Chronic arthritis, as most of you know, is no joke. There is nothing funny about it.

The nomenclature of the disease is nothing but confusion. It is so confused that usually when we start to read an article on the subject of chronic arthritis we have to wade through to the end to find out what the author is talking about, and sometimes we are in doubt when he finishes it. What shall we call the disease? Arthritis deformans? The word arthritis deformans means one thing to one man, another thing to another. As to osteo-arthritis, osteo-arthritis means an inflammation of the bone and joint. As to hypertrophic arthritis, the prime lesion is death of bone not hypertrophy. What makes this death of bone? Almost certainly some living thing, and quite certainly not a bacterial organism. It is absolutely not bacterial. That is one thing I am sure of. When I had the pleasure of showing my slides to the late Dr. Nichols of Boston, who himself did such remarkable investigative work in joints, he said there was one thing sure, the disease was not bacterial. Bacteria, when they get into the bone and joint, give well defined pathological pictures. They are all similar. The x-rays are similar and the clinical picture is similar. Your diagnosis, if you are honest with yourself, may incline strongly to one infection or the other, but until you have taken your material out and have examined it under the microscope, you are never sure what that form of infection is.

The disease we are discussing is just as different from a bacterial arthritis as black is from white. Every change you see in the bone and cartilage is entirely different. You make your clinical diagnosis on it, and confirm the diagnosis with the x-rays, but you know, for instance, that it is not tuberculosis. The minute you see the spikes and ridges of bone you are sure that the joint is not tuberculous. In other words the tubercle bacillus cannot produce these. The necrosis in the marrow of the bone end comes first. Nature's reaction to the necrosis deforms the joint. A traumatic arthritis results from this. A change in the synovial membrane or in the cartilage cannot make a necrosis in the interior of the bone. Trauma is not the cause of this disease we are discussing, but trauma of the joint already damaged by the disease causes the arthritis. Trauma cannot cause a necrosis in the interior of the bone. Bone marrow is protected from all trauma except fracture. All changes in the cartilage are the result of previous disease of the bone marrow or in the synovial membrane.

When you can take your students with you to the laboratory and say: "In this resected femur head we shall find areas of aseptic necrosis", you have something definite. Why is it that orthopaedic surgeons are not interested in the pathology of the diseases they essay to treat? Is there something that sets you apart from all other practitioners of medicine? To speak mysteriously of function and metabolism gets us nowhere. We cannot progress by abstract reasoning and theorizing. What we need are definite facts. We show you specimens of bone taken from middle-aged and elderly persons. These persons usually have abscesses at the roots of their teeth, a portal of entry. Many of them have intestinal protozoa. When we come to cut up the specimens, we find in them areas of aseptic necrosis, in other words, a lesion that protozoa would naturally produce, like an amoebic abscess of the liver, for instance. Kofoid, of the University of California, says he finds the amoeba histolytica in one of our specimens. The results of treatment of these cases at our hands, on this hypothesis have been good.

Dr. C. L. Lowman, Los Angeles, Calif.: It may be of interest to you to know that in the last four years we have been making routine stool examinations at the Orthopaedic Hospital School, where patients are admitted up to twenty years of age. We have found eight per cent. which showed flagellate protozoa. Of the arthritis cases sixty-eight per cent. showed them. Many of our older cases we have been following out to see whether they are the same cases that get marked results from emetin. I do not know any proof that the amoeba is the causative factor. The case Dr. Barnard showed at the Clinic at The Huntington with three different joints involved and after three successive flare-ups in the intestinal tract, was relieved each time with emetin. I do feel there is a parasitic factor in a certain kind of arthritis. Its relation to other causative factors is

still problematical. We have definitely seen relief, however, in certain cases treated for and freed from protozoan organisms.

Dr. M. C. Harding, San Diego, Calif.: I wish to bear out what Dr. Lowman said. For several years we have been making routine study for entamoeba histolytica and the percentage runs up to what Dr. Lowman said. Our results where we do find amoeba infection are far better with emetin and salvarsan treatment.

Dr. R. B. Osgood, Boston, Mass.: I have the greatest admiration for the work of Dr. Fisher and Dr. Ely, for with the exception of the biochemical attack this is the only type of work on this complex problem of arthritis that is likely to discover basic causes. I think Pemberton's work is just as praiseworthy. I do not know of any other men who are doing more to increase our knowledge of the subject than they are doing.

Dr. A. L. Fisher, San Francisco, Calif. (Closing the discussion): I will not take up any time with the nomenclature. Dr. Ely went into that.

Regarding the variety of parasites, we have no particular type of amoeba indigenous to California. We find the amoeba histolytica rarely but we find the amoeba coli most commonly.

As regards the inflammation in the joints and why areas of necrosis occur in the joint, I think it is open to a good deal of discussion. The point that is most logical to me is that they begin as areas of necrosis. It is not bacterial; it may be protozoan. If it is amoeba, it is protozoan of course. The changes in the joint are the ones we observe. As we said before, one is struck by the resemblance between the findings of osteoplastic carcinoma and the second type arthritis. There we had definite carcinoma cells and dead bone around them in the area of bone formation. The point that seems to me most logical is that it is a focus of necrosis which starts at some point. I will not say definitely that it is the amoeba that starts the reaction about the joint. The reaction of the tissues around this dead area is the thing that gives us our histologic and x-ray pictures.

Regarding the circulation in the joint, it is perfectly true that impeded circulation has been described as causing the changes. There is only one thing about it and that is that in the adult these arteries in the end of the femur and the end of the humerus are not end-arteries, but arteries that anastomose freely.

# RELATION OF THE SURGICAL PATHOLOGY OF THE RIGHT LOWER QUADRANT TO ARTHRITIS*

BY REA SMITH, M.D., LOS ANGELES, CALIF.

The nature and etiology of the surgical pathology of the lower right quadrant has been a subject of controversy for many years. As is always the case when there exists a great diversity of opinion as regards cause and treatment of any medical condition, a generally recognized conception of the cause has not been developed. The writer believes that in this particular instance, the lack of correlation of the factors, embryological, anatomical and physiological, which have contributed to produce caecal stasis is the reason for the *many theories* for its production, and the *many treatments* suggested for its cure.

I wish to discuss primarily the thin-walled, blue, toneless caecum, accompanied by one or several of the following conditions—either an anchored ileum, retrocaecal appendix, constricted hepatic flexure, or tightly constricted ascending colon in its mid-portion. This condition (the atonic caecum) has been treated surgically by removal, side-tracking, plication and fixation, the procedure depending upon the operator's own idea of the lesion with which he was dealing. Of these types of treatment, removal has been attended by more immediate risk to the patient, but has produced the best symptomatic results. However, we feel that removal or side-tracking is rarely necessary, and that fixation or plication should never be done.

A brief consideration of the changes of the caecum and the colon in foetal life may lead us to the explanation of the changes we find in adult life. Harvey[1] makes four main subdivisions in the journey which the caecum makes from its inception to its final lodgment in the right iliac fossa, namely,—*Migration*, *Rotation*, *Descent*, and *Fixation*. In the fifth week of foetal life, the primitive gut is attached to the umbilicus and the caecum is beginning to show as a bud on the caudal portion of the gut. As the liver at this stage rapidly increases in size, the bowel is pushed out of the coelom into the umbilicus. Next the relative increase in size of the body cavity permits the return of the gut. The small intestine is the first to return and the large bowel follows. The junction of the small bowel with the large is forced by the small intestine into the upper right quadrant and at this stage the small intestine enters the large from the right and above. This ends the *migration*. The next stage is that of *rotation*, resulting in the entrance of the small bowel on the inner side, or from the left and below. *Descent* starts at this point, and in the latter months of foetal life and the first month after birth the growth of the organ carries

*Read before the meeting of the American Orthopaedic Association, Yosemite Valley, California, June 1927.

it and the ileocaecal valve into the lower right quadrant. Fusion of the various mesenteries results in the position which is termed normal in the adult life. It is well to note that the descent and fusion are relatively late stages in the developmental cycle. Studies in comparative anatomy would indicate that fusion is doubtless a result of the assumption of the erect posture by mankind, and it is just to suppose that on the success of these last two processes will depend to a considerable extent the ability of the bowel to function properly. The caecum and ascending colon are closely but loosely adherent to the wall.

*Mechanically*, there are five fixed points in the intestine which interest us,—(1) the duodenum-jejunum junction, (2) a point on the terminal ileum close to the caecum, (3) the hepatic flexure, (4) the splenic flexure, and (5) the point on the left wall, where the descending colon becomes the sigmoid. In all other parts, both small and large intestines swing freely from their mesenteric attachments, except the ascending and descending legs of the colon, which are loosely attached by parietal peritoneum in their entire length to the side wall. An intestinal tract so attached has what we term normal mobility and functions with normal motility.

The colon has besides the circular and longitudinal muscular layers, four distinct longitudinal muscular bands, which are capable of lifting the caecum a distance of a good many inches in a so called normal ascending colon, pulling from the first fixed point, the hepatic flexure, and are largely concerned in the normal mechanism of emptying the caecum.

The intestinal wall carries within itself the mechanism essential to peristalsis. The law of peristalsis of Bayliss and Starling was worked out experimentally on the dog, with a balloon in the intestine attached to a manometer. It was demonstrated that pinching the intestine just *above* the balloon, caused a cessation of peristaltic activity and a dilatation of the intestine from eight to twelve inches behind the pressure; that pinching of the intestine *behind* the balloon caused a spasticity and great increase in peristalsis ahead of the pressure. In other words, pressure upon a ganglion *contained in the wall of the bowel causes dilatation behind and spasticity in the front.* This is our conception of the production of the thin-walled, blue caecum with caecal stasis.

Given a mobile caecum and ascending colon, due to faulty fusion, the terminal event in the embryologic cycle, we have the stage properly set for the development of a long chain of events. Starting with loss of tone, due either to advancing years, a long strain, or a long physical illness, we have a loss of the lumbar curve, which is the shelf on which the normal caecum lies. With the loss of the lumbar shelf, we have a tendency of the caecum to prolapse. Nature in her effort to lift up a prolapsing organ starts the growth of a membrane at the site of the right colic artery on the mesentery side, which attaches the colon tightly to the side wall by a reduplication of the peritoneum. As this attachment becomes tighter, the colon is rolled to the right and twisted, the prolapsing heavy caecum swings forward and to the left, exaggerating the twist. This twist so pinches the intestinal wall containing Auerbach's plexus that caecal dilatation with lack of

peristalsis follows, and a spastic colon forward from the point of pressure develops. This paralysis of the caecal muscular walls due to plexus pressure is at first intermittent, occurring when the patient is erect and disappears when prone, making it easy to miss, either in routine x-ray examination or on the operating table. We have often an associated tightening of the normal attachments of the ileum, until the ileum is rolled in, again by reduplication of the peritoneum, starting *opposite* the mesentery attachments, forming a Lane's kink. There is often a retrocaecal appendix, in many cases an undescended appendix, which draws the caecum sharply up to the right, so that what has appeared to be caecum in the x-ray is really the middle of the ascending colon. This is usually included in the adventitious attachments of the ascending colon. Actual mechanical fixation interferes with the direct pull of the longitudinal bands from the normal fixed point at the hepatic flexure, so that the caecum can no longer be lifted.

This theory is based largely on deductions from clinical observation at the operating table. Many years ago my assistant called my attention to the fact that all of these cases of caecal block were just alike, meaning that whatever else was present, the binding of the colon in its mid-portion by a peritoneal reduplication was always there. We have demonstrated so many times that it is no longer a cause for remark, that this toneless caecum, dilated, thin-walled, appearing to have no muscle, is capable of an *immediate* return in color, thickness and peristaltic activity. This immediate return of peristalsis upon removal of the plexus pressure must disprove the theory of Lane that the caecum has become toneless through atrophy of muscle from hydrostatic pressure, and the theory that the muscle has atrophied through trophic changes from long toxaemia. Also this disproves the theory of ordinary anatomical intestinal obstruction in the ascending colon. For in all parts of the intestinal tract a simple, partial, anatomical obstruction gives rise to increased peristaltic activity and hypertrophy behind, rather than atony and dilatation.

With the colon pulled tightly to the left, the assistant holding the hepatic flexure in one hand and the caecum in the other, the reduplicated peritoneum is divided with a sharp knife at the white line, which marks its junction with the parietal peritoneum; the ascending colon immediately becomes straight. The edges of the longitudinal incision in the peritoneum are separated four or five inches by the rolling out of the colon, which has been compressed over the right kidney. The caecum immediately draws up, regains its pink color and contracts when pinched between the gloved finger and thumb. We plant in this denuded area a free omental graft, carefully stitching the omental edge to the edge of the peritoneal incision. Interposition of tissue apparently prevents reformation of the constricting membrane, as we have never re-operated on one for adhesions in a series of 134 cases scattered over a period of ten years.

There are many other conditions capable of causing stasis. I have taken this time to describe the condition most frequently met and most misunderstood. Adhesions following abdominal inflammation, either with

or without surgical intervention, cause all kinds of partial obstructions. Delays in the ileum seem to cause more toxic symptoms than those in the colon.

I am often asked—"Just what surgical operation do you do for the relief of intestinal toxaemia?"

And my answer is,—"Any intelligent operation that will restore the physiological function to the bowel."

It is not fair to treat the gastro-intestinal tract as a hose and base the surgical procedures upon anatomy only. Gastro-intestinal surgery to be successful must be planned not only to restore the anatomical parts, but also to assure perfect physiological function.

The clinical manifestations of caecal stasis are varied and far reaching. The condition which has most interested us because it is not nebulous, is chronic polyarthritis. We think we have clinical evidence to substantiate the statement that chronic polyarthritis is caused by the absorption of bacterial toxin or improper metabolic end products due to an unbalanced ileocaecal flora dependent upon an ileocaecal stasis, with an occasional shower of bacteria from the same source. We have found that it is almost impossible to change the flora to a normal relationship between the gram negative or putrefactive and the gram positive or fermentative germs in the face of a mechanical caecal block. We have found, also, that after removing the block, the same dietary treatment, based upon the bacterial examination of the stool, which failed to influence either the flora or the symptoms before operation will slowly change the flora back to normal, and the disappearance of the pain, stiffness, and contraction of the arthritis goes hand in hand with laboratory reports upon the flora. This, however, has taken from fourteen months to two years and has been a long pull for both the patient and the doctor, and has necessitated constant observation of the patient.

The routine examination and treatment which we have developed is very simple;

*First,*—We investigate and clean up the ordinary sources of focal infection, such as teeth, tonsils, sinuses and pelvis;

*Second,*—Gastro-intestinal x-ray for mobility and motility of the intestinal tract,—especial attention being given the ileocaecal coil;

*Third,*—A balanced diet for forty-eight hours so that we may maintain as far as possible the same conditions to have a standard for comparison, and a stool smear made of a freshly collected specimen on the morning of the third day.

If the stool examination shows an unbalance on the gram negative or gram positive side, and the x-ray has shown no gross pathology, we institute a medical regime designed to restore a normal intestinal flora. We attempt to restore the lumbar curve; fit an abdominal belt; have patients sleep with the shoulders low and encourage the caecum to stay up to prevent the paralysis by twist. If the gram negative greatly predominates, which is the rule, we use a non-protein diet; give Squibb's paraffin oil three times a day; acidophilus milk; iron, arsenic and strychnia for appetite, and

hydrochloric acid if needed. If the gram positive predominates, we give milk diet and oil. The fermentative cases clear up very much more quickly than the putrefactive.

A word about *acidophilus milk:* We have recently obtained a very much better growth from the use of milk by mouth and also by caecal implantation with a product that is made each time from a freshly collected strain of the acidophilus bacillus taken from the meconium of a new-born babe. Apparently the growth of the acidophilus bacillus proves the bacteriological rule that the farther the replants get from the mother culture the more attenuated and less active the bacteria becomes.

If we are unable to change the flora in this way, after a trial of some weeks or months, we recommend surgery, and put the patient back on the treatment as before. Our experience has taught us that it is a waste of time to try the medical regime in the face of a distinct caecal block and prolonged stasis. We do the surgery first in these cases and then start the same medical treatment as an after-surgical treatment.

The only other routine measure has been blood examination for uric acid and the giving of urodonal when uric acid is high.

We have recently inaugurated the use of the Schellberg tube, which can easily be passed to the caecum, the colon thoroughly washed and acidophilus culture implanted directly into the caecum. From our short experience I have great hopes of being able to shorten the period of convalescence from months to weeks.

There comes a time when the stool is normal and the joints are cold, that these patients need corrective orthopaedic procedures. Ellis Jones was the first to call my attention to the fact that he could do any type of operation or manipulation on these joints without reaction, which has always been the bugbear of the orthopaedic surgeon in treating arthritis. He remarked that he seemed to be dealing with the "ashes of a dead fire", and we are very careful to be sure that the fire is out before starting any reconstructive joint work. The joints that have given us the greatest difficulty in getting motion have been those deliberately fixed by plaster casts, upon the assumption that arthritis was an incurable disease and that a straight leg, stiff, was better than a bent one.

The question of the part played by the amoeba and the flagellate protozoa has been of great interest to us. We rather feel that flagellate protozoa, and the so called non-pathogenic amoeba are incident to a stasis and clear up when the stasis is relieved. We think that they play a rather large rôle in the gram negative cases by furnishing protein for putrefaction and in their presence in large numbers it has been impossible for us to restore a balance to the flora. We are sure that the proper treatment for them is to drain the pool, just as a farmer drains a pond occurring in the course of a stream when he wants to get rid of algae, pond lilies, and other growths due to the slowing of the current.

1. Payne, R. A. and Trahar, F. C.: Developmental Rests in Caecum and Ascending Colon and Their Roentgen-Ray Diagnosis. Am. J. Roentgen, VIII, 643,1921.

# SURGICAL LESIONS OF THE RIGHT LOWER QUADRANT DEMONSTRATED IN PATIENTS WITH CHRONIC DEFORMING ARTHRITIS BY X-RAY OPAQUE MEAL EXAMINATIONS*

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*From the Roentgen Department of the Hospital of the Good Samaritan*

The findings presented herewith are not particularly new, and are brought forward with apologies to those to whom it is an old story. However, the number of patients we are constantly seeing in our laboratory, in whom we find the particular lesions we are to consider, who have been examined in other laboratories throughout the country with negative findings, would seem to warrant a renewed attention to this subject. These people are sick: a history of any of them is usually sufficient to convince one that the gastro-intestinal tract is at least a factor. Yet no definite evidence of gastro-intestinal pathology is found in the usual x-ray examination. However, many of them have pathology in the intestines and it is of such a character that it can be demonstrated by the opaque meal study. For the last ten years we have been finding, in our laboratory, x-ray evidence of the lesions described by Dr. Smith, of such a definite character that for the past six or seven years we have, with considerable confidence, been naming them in our reports.

In 1922 I presented an angle of this subject before the American Roentgen Ray Society. Only occasionally has a paper appeared in American literature before or since, until the last two years, during which time there has seemed to be a rather active interest developed in the study of the intestinal tract, chiefly the colon, especially by clinicians, rather than roentgenologists, endeavoring to make deductions as to physiology and pathology from various types of opaque media x-ray studies. The deductions from these studies of the gastro-intestinal tract, as shown by the literature, have been as varied as the observers, and run from almost purely statistical to highly theoretical and speculative observations. One of the striking things noted about these articles is the almost uniformly incomplete type of examination on which the information is based, one observer discarding the meal examination as unimportant and relying on the enema; another making observations at stated periods only, and eliminating even some of those that are usually considered standard everywhere; another giving a meal, and relying on observations made subsequent to the administration of a cathartic, etc. There is no uniformity of method of examination and as a result there is no uniformity of resulting deductions,

*Read before the meeting of the American Orthopaedic Association, Yosemite Valley, California, June 1927.

or any very definite addition to our information with regard to the pathology and physiology of the intestinal tract.

When we first started doing gastro-intestinal opaque media examinations, we used the single meal, made many observations and followed it through as long as we thought we could get any information. This was originally done because of inexperience and fear that we would overlook something from lack of care and knowledge. Since, we have come to believe that the extra trouble and work and time that has to be given to this type of examination, by both the patient and the roentgenologist, is compensated for by certain additional information that is obtained. For ten years in private work we have used the single meal with immediate observations, and observations at six hours, nine hours, eleven hours when necessary, twenty-four hours, and thereafter each twenty-four hours until we were satisfied no further information could be had. An enema followed this, if thought necessary. For the past year and a half or two years, we have been doing in addition to this, on most patients, a gall-bladder dye study. During a portion of this time I had charge of a clinic as well, and did about twelve hundred so called double-meal examinations, with the immediate and six-hour observations combined and a twenty-four hour study only. This has afforded opportunity to compare, in a rather thorough way, the relative value to me of these two types of examinations, and after this experience I am thoroughly convinced that the longer, more thorough examination is worth while, both to the roentgenologist and to the patient.

A diagnostic method is only of complete value when its possibilities have been exhausted. Short cuts to knowledge are, as a rule, dangerous methods to rely upon. This is especially true in the type of work which comes to a well equipped modern hospital and x-ray office in these days, where a large proportion of the patients are referred for study by internists and surgeons, because they have been passing around from physician to physician without a real diagnosis and with very little resulting permanent benefit from treatment. These patients have of necessity to be combed with a fine tooth comb from every standpoint, not only by the x-ray, but from all angles, so that the thing which was missed in previous studies shall not be missed again. The best evidence we get in our laboratory of the lesions described by Dr. Smith, in the ascending colon and ileum and those involving the caecum, and the best evidence with regard to motility in, and mobility of, this portion of the colon, is obtained at the nine-hour observation, which is the one most often omitted or ignored in the routine type of examination. In addition we believe that it is easier to demonstrate at this observation the presence or absence of a filled appendicial lumen and to determine its mobility and the question of its tenderness, than at any other time. We believe more appendices are visualized at this observation than at any other one observation in the series.

What are these lesions and how do they manifest themselves in connection with an opaque meal study? Dr. Smith has told you that the

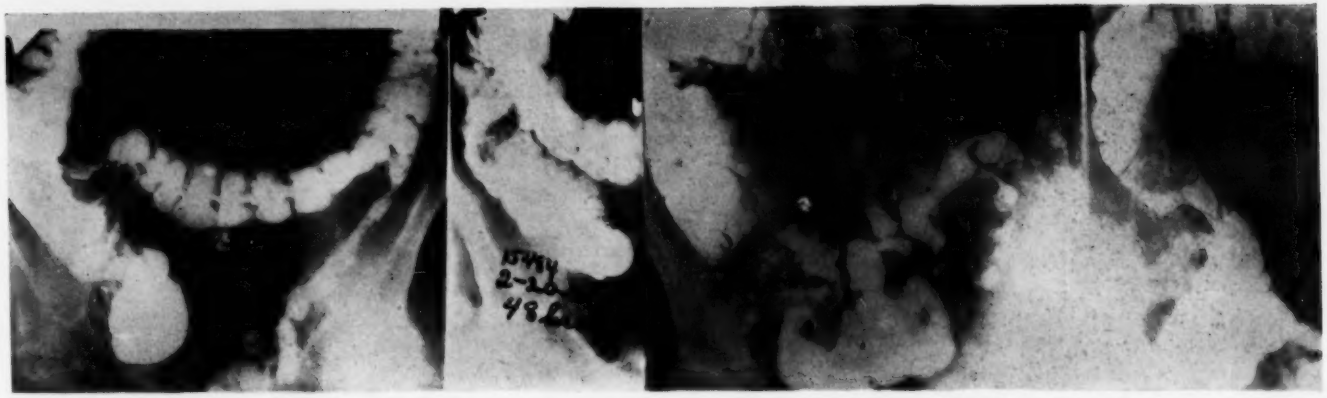

FIG. 1 FIG. 2

Showing normal appearing ascending colon, when caecum is up, patient supine, and evidence of twist and constriction due to tension on band and rotation of gut when caecum is in pelvis, patient erect.

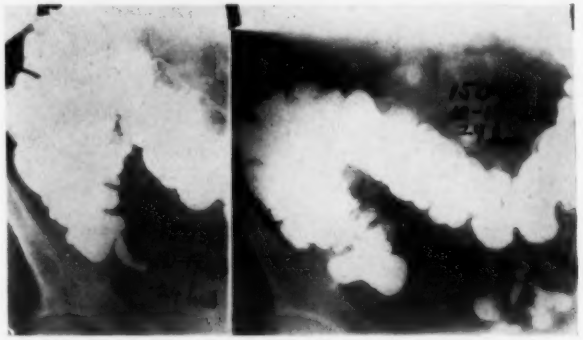

FIG. 3

Showing normal appearing caecum and appendix when they are up and there is no tension on band, and disappearance of appendix behind caecum due to rotation, and constriction just above caecum when band is placed on tension, by descent of caecum.

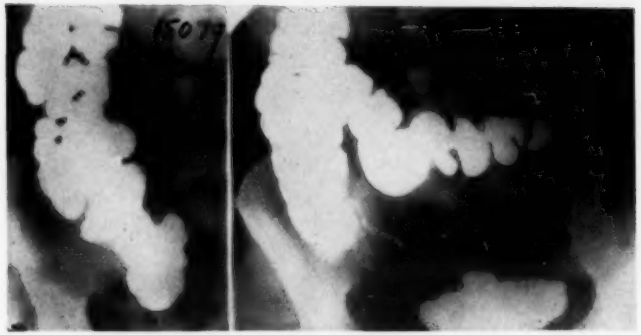

FIG. 4

Showing effect on caecum and ascending colon of descent that is limited by an adherent appendix. Normal emptying not to be expected.

typical, most commonly found lesion is an adventitious membrane originating on the posterior abdominal wall or mesentery, that spreads out fan-shaped to the right over the ascending colon and is attached to its right peritoneal border. These membranes vary in actual length and in length of attachment to the colon and have a definite tendency to limit the *normal downward* movement of a movable ascending colon and caecum. What happens when the patient with a lesion of this kind stands erect and gravity takes a loaded caecum downward into the pelvis, is difficult to describe, but easy to visualize if once the mechanism is understood. The only satisfactory way to demonstrate any of these lesions is with the fluoroscope. Radiographic examinations alone will frequently result in failure to show the characteristic deformities and in failure to determine mobility as well as motility. For that reason it is frequently difficult to show evidence of these lesions on films or lantern slides, while they may be easily demonstrated with the palpating hand before the fluoroscope.

The twist in the ascending colon is the most important factor in producing the local stasis that is found in the patients under consideration, and can practically always be recognized during the course of the opaque meal study if it is present. It is most frequently demonstrated at the nine-hour observation, although frequently seen at six hours and at each twenty-four hours thereafter as long as the caecum remains loaded. As you can readily understand if you have the mechanism of the lesion in mind, if the caecum lies on the ilium in a fairly normal position with no tension on the membrane, an entirely normal outline to the ascending colon and caecum may be seen, with normal appearing haustrations, so that unless the caecum is observed in the pelvis with tension on the membrane, its presence may not be evident. In order to demonstrate it under these conditions, it is frequently necessary to place the patient in the standing position and observe him with the caecum dropped into the pelvis, when there is seen a rather characteristic crook or kink, caused by the twist, usually just above the ileocaecal level and at the lower border of the membranous attachment, with a definite thinning of the shadow of barium at and distal to this point, due to a narrowing of the lumen of the bowel by the torsion. In a typical demonstration either curved, spiral, or longitudinal folds of mucous membrane of the bowel can be seen, or the appendix is turned with the twisted

FIG. 5

Nine-hour observation showing ileum nearly empty, caecum large, heavily loaded and in pelvis, narrowing just above due to twist from pull of band under tension and thinning of barium shadow distal to twist, due to hyperperistalsis.

FIG. 6

Opaque enema in same patient as Fig. 5. Note shortening of ascending colon due to lateral distension of bowel from enema. Caecum is now up out of the pelvis and with no tension on band shows normal outline with no evidence of twist. Enema masks evidence of pathology shown in Fig. 5.

caecum so that it lies either posteriorly or to the right side, instead of on the inside and to the left. An appendix seen in this position can hardly be explained other than by rotation of the bowel on its long axis, except in the few cases of congenital non-rotation, which are occasionally seen. In making these examinations for the purpose of demonstrating these lesions, it should be borne in mind that we are dealing, in the majority of cases, with a ptotic patient, with one whose abdominal walls are likely to be relaxed and whose intra-abdominal tone is poor, with one who has an abnormally mobile ascending colon, caecum and hepatic flexure. These are not always found, but they are the rule. Therefore it is ordinarily easy to bring the membranous attachment under tension and produce a twist in the ascending colon by placing the patient in the erect position. The mobility or lack of mobility, and the presence or absence of evidence suggesting a membranous attachment, are the important points to determine for the attending physician, so that the question of necessity of surgical interference, to establish drainage in the infected bowel before treatment, can be determined. These things can not be determined with any great certainty with the ordinary routine opaque meal and enema examination.

Again, subsequent observations, made at each twenty-four hours, are important because frequently these patients have what they think are satisfactory daily bowel movements, when subsequent repeated observations will show the caecum filled, with only a gradual emptying over a period of forty-eight, seventy-two or one hundred and twenty or more hours. We used to lay great stress upon hours of stasis. This was natural as our original idea in regard to this matter was gotten from the work of Lane and Jordon. At the present time, we think that the presence of the evidence of the characteristic lesion, described above, is the most important single piece of information. Next, is the evidence of the different emptying time between the caecum, or the area involved, and the colon distal to it. If the shadow of the ascending colon is thinned out and the barium moves along, as it almost always does in a typical case, leaving a gap in the shadow between the caecum and the balance of the colon distal,

we have evidence of the existence of the physiological block, spoken of by Dr. Smith, due to one of the various types of lesion which we believe to be its cause. In other words, the presence of a demonstrable local delay in emptying, when compared with the bowel distal, is much more important than the number of hours of actual local stasis. Our experience would lead us to believe that the length of time that the meal remains in this local area of stasis frequently varies under different conditions, at different times, in the same patient.

There are, of course, other lesions of the ileocaecal coil, which result in the characteristic local stasis and delay in emptying. An adherent, retrocaecal appendix may cause enough deformity to prevent normal peristalsis, resulting in a local stasis; deformities due to adhesions following operations for removal of the appendix may do the same thing, and I would say here that we frequently find in these patients the evidence of the twist due to the presence of the membrane involving the colon, that was undoubtedly present and overlooked at the operation on the appendix. A high appendix, adherent in any part of its length to the abdominal wall, may act as a guy rope suspending the otherwise movable caecum when the patient is erect, interfering with peristalsis and favoring stasis of a local character.

In making a radiograph for a record of all these lesions we have adopted, partly for our own convenience and partly to get as near as possible a record of what was seen on the screen and get it under the same conditions, a simple method of radiographing the patient in the supine and erect positions. This is done by substituting a film for the fluoroscopic screen and making an exposure without change of position of the patient, the patient being erect or supine as desired.

With reference to the arthritic patients referred to by Dr. Smith, the x-ray findings are so uniform in the majority of cases that one can almost predict what will be found. I realize that I am flying in the face of tradition and the generally accepted opinion of roentgenologists when I make some of these statements, and it is with some timidity that I make them. However, I am perfectly sure that if these men will make their examinations in the manner in which we make ours, they will find the same pathology that we do, and I cannot refrain from emphasizing this as much as possible. I believe one reason why roentgenologists and others, who do opaque media examinations, fail to find or ignore these evidences of pathology, is that the men for whom they are working are not interested particularly in this type of thing. One has to have a certain amount of encouragement to do the extra work and take the trouble necessary. This I fortunately have had from my associates at our hospital. Also, before I started doing this type of examination and looking for these particular lesions, I was fortunate enough to be able to stand across the table in the operating room from Dr. Smith during most of his abdominal surgical work for a period of over a year. During this time pathology, which he was interested in and which he hoped we would be able to discover and recognize with the x-ray

examination, was repeatedly shown in the open abdomen. This is an experience which has been invaluable, and which thoroughly convinced me that a pathological condition was present in these patients, and that it was a factor contributing to their illness. Then, too, working chiefly in the hospital, I have since been able to see quite a large number of these patients in the operating room and was able to check up our mistakes as well as our correct diagnoses.

## DISCUSSION

NOTE: The paper referred to in the following discussion by Dr. Robert B. Osgood, was published in the *Journal* for October 1927 under the title of "Etiologic Factors in Certain Cases of So Called Sciatic Scoliosis" (IX, 667).—*Editor.*

DR. ELLIS JONES, Los Angeles, Calif.: I am especially grateful for this opportunity to discuss Dr. Rea Smith's paper. For seven years I, amicably or otherwise, refused to submit my patients to colectomy, short-circuit, or any exploratory laparotomy which attempted to improve their arthritis. Then I saw several patients who had been operated on by Dr. Smith and I found that the acute arthritis gradually subsided. These joints were cold and I could correct the deformities without reactions. Being convinced against my will, I have taken an especial interest in the work of Dr. Smith during the past three years. We need every possible adjunct in general surgery and the specialties in the treatment of this chronic condition.

In reference to type II, I have recently seen only one case which has been singularly protracted. I regret very much that Dr. Smith has not had the opportunity in the scope of his paper to present case reports. This particular patient was a man of forty-five who, when I saw him two years ago, weighed 210 pounds and had a generalized diffuse type II osteo-arthritis. He was treated in another clinic, faithfully treated with emetin. Amoeba were found. When I saw him three months ago, he weighed 145 pounds and his arthritic symptoms and particularly the profound mental depression were markedly increased. At operation Dr. Smith found the pathology that he has already described to you. I saw that man two weeks ago. I had anticipated giving him joint nursing, heliotherapy and a few other methods of treatment. I found it unnecessary to give him any treatment whatever. That is only a single dramatic instance.

The treatment of arthritis is slow and tedious. It has been a very great assistance to me and to all of us in Los Angeles to have this type of surgeon, a master surgeon and clinician, giving us as orthopaedic surgeons the best of his time and experience in an earnest attempt to solve a great problem.

DR. RAY TAYLOR, Los Angeles, Calif.: The ordinary type of gastro-intestinal study as usually made fails to show the pathology in the colon. Frequent and prolonged observations are necessary. The barium meal must be followed until the right colon is empty.

DR. MARK H. ROGERS, Boston, Mass.: I wish to thank Dr. Taylor and Dr. Smith very heartily for presenting this subject. It is a tremendously important subject. Chronic arthritis is one of the big problems in medicine that has got to be tackled harder than we have ever tackled it before. It is one of the things that has troubled all of us. Practically every year we have various papers on chronic arthritis. It is not discouraging, because they are so varied and attack the subject from different standpoints. I think they are rather encouraging in showing that some progress is still being made. Most of the progress is clinical rather than purely scientific. I do not know whether we will ever get at the problem from a purely scientific standpoint, but it is the clinical evidence that is accumulating that is probably helping us.

I take it that all these cases that Dr. Smith is talking about are of this type I, the so called infectious or proliferative type. Type II, or the hypertrophic, in my opinion,

is a much more settled problem and probably is not to be considered in this same category. Now the accumulation of evidence in clinical work in this type I is rather pointing towards the intestinal tract. We know perfectly well that certain focal infections will give the same end results as shown in type I. I think that has been proved many times, especially in the more acute cases. There are other cases that are hard to treat in which the evidence seems to be pointing towards the intestinal tract as the focus of infection. That seems to be the basis of Dr. Goldthwait's mechanistic treatment. That is somewhat the basis of Pemberton's work. The only thing contrary is Burbank's work and I am not sure that has been proven.

I cannot discuss all the details of this operative work. I hope the internists will take hold of this problem in the future a good deal more than they have so far. I do not feel that it is so much an orthopaedic problem as it is a problem from the standpoint of the internist, the x-ray man and the orthopaedist. I hope the internal medicine men of this country will work up the study and whenever they make their report will tell us what kind of arthritis they are dealing with. If they will tell us what they are dealing with, we will have a much better basis to work on.

Dr. Walter Truslow, Brooklyn, N. Y.: We must not lose sight of the fact that we are here called upon to discuss a physical sign and a symptom only. A physical sign and a symptom of what? Dr. Osgood, in his usual thorough manner, states that the absorption of toxic substances elaborated in the large intestine and associated with intestinal stasis may cause an arthritis in the low spine. He points out that if this absorption of toxic substances is located especially in the sacro-iliac joint of one side, pain in the course of, or in the sensory distribution of, the sciatic nerve of that side is very apt to occur; and in six illuminating illustrative cases he shows that scoliosis, with a body lean away from the affected side, is to be noted. In this paper, the relationship between one of the focal regions of infections—and I agree with Dr. Osgood, that the large intestine is rightly given first place as such a focal location—and the symptom, sciatic pain, and the physical sign, scoliosis, are clearly brought out.

It is often of value to lay stress upon a physical sign or upon a symptom, but I would protest that the title of this paper does not name any pathological entity.

Can we not see this subject more clearly if we call the physical sign "sacro-iliac scoliosis", calling attention to the fact that sciatic pain is also often associated with this physical sign?

If this is agreed to, we might make the following classification of sacro-iliac lesions, with reference to etiology, and to this physical sign and this symptom:

1. Sacro-iliac strain of purely mechanical origin—traumatic, static, anatomical variation, etc. Scoliosis or referred sciatic pain rarely present, although local pain and tenderness often present.

2. Those directly traceable to a focus of infection. Scoliosis, with body lean away from the affected side, and sciatic pain on the affected side, fairly constant. Dr. Osgood, in this paper, has made me believe these two factors may almost be considered pathognomic of the focal infection type of sacro-iliac lesion.

3. There is a third type, combining the traumatic and the infectious origin, in which the diagnostic factors emphasized in Dr. Osgood's paper play a varying part, and which taxes our observation in evaluating and our skill in treating.

Dr. Osgood, in this paper, stresses the infectious type and outlines treatment. He rightly gives much attention to the eliminating of the cause—(a) attention to diet, giving such foods as will limit residue in the intestine; (b) the administration of mineral oil with agar, by mouth, perhaps aided by catharsis; (c) colonic irrigations; (d) carefully administered abdominal massage. He also cares for the mechanical side of intestinal stasis by (a) certain bed positions and exercises, lessening ptosis, (b) by posture training and exercise in standing and walking, (c) by short-time use of corsets or light body braces, calculated to maintain non-abdominal sagging posture.

In the illustrative cases, Dr. Osgood shows that when early treatment did not pay sufficient attention to removing the intestinal cause the patients did poorly and that when

such eliminating and upbuilding treatment was carefully followed through, the results were good.

The paper is valuable in that it ably and timely calls our attention to the relationship between absorption from the large intestine, low back, especially sacro-iliac arthritis and the physical sign scoliosis and the symptom sciatica; and in that it carefully reviews again the thorough regime which he and his associates have followed in eliminating this intestinal cause.

DR. C. L. LOWMAN, Los Angeles, Calif.: Dr. Osgood's paper called to my mind, when I read it, an old case many, many years ago in which we failed completely. A girl stenographer, rather emaciated and with all the postural and anomalous faults which you would expect to find in a skeleton, was sent to me by an internist. I was prepared to start the usual postural correction for scoliosis. She gave a history of constipation which was under treatment. She returned in three months apparently well, cured of her scoliosis and backache. She had had an appendectomy which did the trick.

Dr. Osgood brought out the spasticity factor. In a conversation with Dr. Kofoed of Santa Barbara, he spoke of a very important factor: i.e. the relation of emotional stress to spasticity. The cases that would become corrected by the use of oil, under extra stress or excitement, would relapse to the old condition. He pointed out particularly the very bad influence the earthquake had on these cases. One woman who had a bowel passage only once in six days after the earthquake, had had perfectly normal bowel movements.

I would like to add my opinion to Dr. Osgood's statement regarding low back pain. I think the low back pains which are neuritic and arthritic are many of them connected with the intestinal condition.

In relation to massage, we have for many years, in studying positions for massage, altered many of them, especially for abdominal cases. In thin individuals, the vertebral column projects upward into the body about three inches and leaves the intestine in a sagging position across it, forming pockets on each side with a valve in the middle. In massaging cases of this kind, if the patient is turned on the left side with the knee drawn up in a three-fourths position or turned clear over on the face, the massage will be much more effective and will give a great deal more relief. This position allows the intestinal loops to fall forward off the column and the lumen opens, allowing free passage of contents and gas.

DR. JOHN WILSON, Los Angeles, Calif.: I feel that we are deeply indebted to Dr. Osgood for the comprehensive description of this condition. It is a very common practice to attribute these conditions to focal infection, removing a few teeth and perhaps the tonsils, and in some instances, massaging the prostate. I do not speak disparagingly of the elimination of focal infection. It is an important factor but we know cases have been treated from this angle entirely too much. These individuals often make a spontaneous recovery in six or seven months irrespective of the elimination of the focal infection and we have been unable to account for it. The disease has all the characteristics of a self-limited thing. I think we have all had patients who have visited the various watering places and with the forced fluid intake, have been much relieved. It may be that the improvement from elimination of amoebic infection is the result of free intestinal elimination. I have in mind a man who in the past five years developed a sciatic scoliosis each year between the first of July and October that was due to some type of intestinal infection. He now takes care of his intestinal tract and has not had a recurrence for two years.

We have heard a great deal of discussion as to treatment of the types of cases. It is both surgical and medical. We have heard a presentation that is well worth the consideration of every one.

DR. LLOYD T. BROWN, Boston, Mass.: It has been my pleasure and opportunity for a great many years to work with a group of men who are working entirely on the chronic problem. I think working on the chronic problem probably tends to give one a different view-point than comes to those who are seeing mostly acute cases. This problem of

chronic arthritis I think everyone of us would like to pass on to someone else, but we cannot do it. It is interesting to come out and hear all the new attacks that are being made on this problem. My own point of view about it is this: Chronic arthritis is probably the most common disease we are up against; but if you look around among your patients and among the ill in general, you will see that there is not very much crippling from arthritis. This means only one thing, namely, that the micro-organisms which cause chronic arthritis are controlled sufficiently by the normal processes of the body to keep the patient from becoming a hopeless cripple. I do not know how many patients get well, nor how many people have arthritis. In teaching students, I have been in the habit of telling them that probably seventy-five per cent. of all people who have arthritis get well. I think that the same conditions are present in arthritis as are present in the stiffness which we feel in our joints when we get up in the morning or after having come down the ledges the day before.

Following this seventy-five per cent. are about twenty per cent. who do not get over their arthritis in the usual way. They are the ones who go to one or more of the various specialists for treatment, and after this they usually entirely recover.

What must be our conception of the cause of arthritis if we take into account that so many cases recover with so many different kinds of treatment, or even without treatment? It is our feeling that there is no one cause for arthritis. We believe that the normal physiological balance of the body machine, owing to the many possible causes of fatigue, becomes changed, and that then the body is open to any condition which the particular type of physiological imbalance may lead to. The one most common condition found in this physiological imbalance is faulty body mechanics with lack of muscle tone. This lack of tone is not only in the extremities or affected parts, but also, and of greater importance, in the body itself, and by this I mean the muscles of the abdominal wall; the intercostals, and especially the diaphragm which, with its lack of tone and poor function because of its bad mechanical position, cannot keep up the proper circulation to the abdominal viscera, which in its turn leads to chronic visceral congestion, constipation, etc. With these conditions present, it is easy to understand how the removal of tonsils or teeth, or a focus of infection somewhere else, as in the intestinal tract, may take the extra burden off the machine, and thus help restore the normal physiological balance.

There is, however, unfortunately, a small group of arthritics who, after the removal of all possible foci of infection, do not get well. These are the ones who have seen every kind of a specialist and still do not get well. How are we going to approach this group? There is only one way. They must be approached from all angles. The angles spoken of today; the caecum and the intestinal tract, as a whole, of course, are important, but we must remember that in dealing with our patients every patient is a law unto himself. We are all made differently, from an anatomical standpoint, and what may be abnormal for one, may be normal for others. It is a question of function of the body as a whole and not just one part of it. Therefore, in our treatment of these patients who are carrying an overburden for their machines, we should realize that it is not only necessary to get the various organs of the body working regularly, but that we must get the whole body working habitually, correctly in the standing, sitting, and lying positions.

It is by such means and by the cooperation of the general surgeon, the internist, and the orthopaedic man, and the other specialists, that our knowledge of arthritis will be increased and our ability to help the patients of this group especially will be much greater.

Dr. J. T. Rugh, Philadelphia, Pa.: I recently heard a very prominent abdominal surgeon attack the useless appendectomies and the unnecessary work done in so many cases of pseudo-appendicitis. He stated that in every case past twenty-five or thirty years of age, a removed appendix is reported by the pathologist as a case of chronic appendicitis and shows chronic disease which, however, has been a symptomless condition. It seemed to me he spiked his own guns in making that statement, as we know that a focus of disease in any part of the intestinal tract is always potential for trouble in joints.

I should like to ask Dr. Smith in how many cases of caecal trouble he has removed

the appendix and in what percentage of these he has found a chronic disease. Further, does he consider a chronically diseased appendix a factor in the production of these symptoms?

DR. ROBERT MCE. SCHAUFFLER, Kansas City, Mo.: It is probably hardly necessary in this august assembly to call attention to the fact that the cases which Dr. Osgood presented are the minority of the cases. The majority of the cases of sciatic scoliosis still remain in the mechanical group and are cured by mechanical means which he knows so well how to use. These cases he presented belong to the minority portion of that group.

DR. F. H. ALBEE, New York, N. Y.: I certainly was very much pleased to hear these three papers. How important I consider this matter can best be expressed by telling you that when changing my office two years ago I put a colonic irrigation equipment in the new office. The reaction of colonic treatment on a great variety of cases, including low back pain, "sacro-iliac strain", sciatica, lumbago, as well as certain cases of persistent flat-foot and tennis elbow in which Dr. Osgood is interested—cases which come under the diagnosis of musculofascitis—has been most beneficial. The term "musculofascitis" was selected because the symptoms occur largely at the fascial insertions of muscle to bone. They ordinarily begin in the lumbosacral region, and in a large proportion of the cases we have had the symptoms were referred to that region.

Nothing has been said about the analysis and examination of the stool. The recent work along this line, especially in the examination for amino-acids, histamin, etc., has a very important bearing on this subject. I have been studying this very carefully and hope soon to publish results. I have now over 200 cases which are classified as musculofascitis.

As far as treatment goes, I believe operation can be avoided in many cases. The routine that we have been carrying out is an alkaline treatment, low enema followed by two drams of calcium lactate in a two-quart solution. The irrigation is given with the patient in such a position that the buttock is very much elevated. The third treatment consists of sodium carbonate, a two-quart solution (one dram), followed by massage with an attempt to get the solution into the caecum as far as possible. This confirms Dr. Smith's findings, although approached from a slightly different angle. I am positive that an abnormal change in the intestinal flora, and toxic absorption of the high colonic content are important underlying factors in many of our orthopaedic cases.

DR. A. L. FISHER, San Francisco, Calif.: Dr. Smith spoke of operating on some of these patients who have been through this treatment of the internal use of emetin. I want to issue a word of warning about operating after the use of emetin. Dr. James, of Panama, who has probably had a bigger experience with amoebiasis than any one else, makes an arbitrary period of 140 days before he operates on a patient who has had emetin. Emetin is a drug that has to be used with a great deal of care, and the people who have had it do not stand operation well.

DR. SAMUEL KLEINBERG, New York, N. Y.: Like the other gentlemen I have been surprised and astounded that in a certain number of cases of chronic arthritis colonic irrigations used thoroughly and carefully have given such marvelous results. I can recall at least a dozen cases in which there was very extensive involvement of numerous joints, and in which the swelling subsided and the patients became apparently well. The difficulty is in knowing in advance which are the cases which will respond to colonic irrigation. I am convinced that in a small percentage of cases colonic irrigations are almost specific, evidently by removing mechanically the infecting agent.

Regarding Dr. Osgood's cases, I was very much interested in this group. I think we still have to think of sciatic scoliosis as being a symptom-complex, the result of injuries or lesions of the soft parts of the back, of the vertebrae, of the sacro-iliac joints, or of a sciatica. This group which Dr. Osgood has so well described gives us an additional cause. I think we should avoid such terms as sciatic neuralgia. We are confused enough about sciatic scoliosis, but we should at least retain that term until we have a better terminology.

DR. REA SMITH, Los Angeles, Calif. (Closing his part of the discussion): It has

never been my privilege to receive so much education in such a short time as I have this morning. It has never been my pleasure to listen to a group of men who knew so much about the subject I have been interested in, or to be able to talk to them. I am very much interested in hearing that the orthopaedic men in the East and all over the country are going at these chronic, low-grade arthritics with the idea of an intestinal source of infection. I have been talking about it for a long time and there was a time when I was ridiculed in all our medical meetings and every time I got up, they said "Here comes some more intestinal surgery". Perhaps I laid too much stress on the surgical part. The surgical part seemed at that time to be the important thing. As a matter of fact, we do not operate on one out of every six that come to us. Unless Dr. Taylor can demonstrate the thing he showed you, we put them on medical treatment. The treatment in our experience is largely medical. When we come to the operative cases, these patients have been through all kinds of treatment and are willing to try anything. As we had some success, I became willing to attack those who had not gotten so far. The ones which do not have the conditions Dr. Taylor has shown get better. I think they are all medical cases and will respond to colonic irrigations and diet.

Concerning Dr. Rugh's question about appendicitis, I think "chronic appendicitis" is a misnomer. I do not believe such a thing exists. Every appendix you take out in the adult shows changes, because there is an obliterative appendicitis which is a natural thing. In old age we find the appendix entirely obliterated. I think there is a recurring appendicitis, an inflammation which comes, subsides and comes again, but "chronic appendicitis" is often a caecal stasis. Often the appendix is in this membrane. We always take out the appendix in the course of this operation because it is bad mechanics to leave it. It is mixed up with the fusion of the membrane, but we never get a report from the laboratory regarding the wall of the appendix. I think the reason our general surgical literature is full of the failures to correct many conditions by the removal of the appendix, is because the appendix was only a small part of the cause. The original part of this paper stated that so called chronic appendicitis is only part of a general localized condition in the right lower quadrant and the appendix ordinarily must be removed in order to clear up other pathology. I think you will get no clinical result with these patients by just taking out the appendix and leaving the rest of the pathology. I was very much interested to hear Dr. Lowman say something about emotional things. I have not talked about that. I have observed it for a long time. There is no question at all but these people, getting on very well after an operation, will under a severe emotional stress show a relapse to the original condition. In two cases this occurred following severe emotional stress, in one instance a sudden death in the family and in the other a broken engagement, and in both patients the laboratory showed that the flora had gone back to the original condition. It took months to get those patients back. There is a reason for that. The flora of the intestinal tract in its various parts is dependent on the chemistry—a gram negative in an alkaline medium, a gram positive in an acid medium. The chemistry of the intestinal tract depends on the biochemistry of the individual cell and the secretion of the individual cell is under the influence of the nervous system, and fright, worry or anything else changes the flora almost immediately. That is the reason why we have a so called nervous diarrhoea. I believe it develops not through the nerves but through a change in flora. When these patients are getting better and have a sudden emotional excitement, the whole course of treatment has to be started over again.

There is one type of this chronic arthritis in which we have not been able to do anything. That is the psychic type found in old maid school teachers and patients with a bad home environment and no money to take care of themselves after they go home from the hospital. Those patients I will not operate on, not because they will not react, but because they are upset emotionally. I analyzed my list of operated cases a year or two ago and found thirty cases out of one hundred who were no better. I took the histories of those patients and found they were all of the same type, almost all of them were old maid school teachers.

Dr. R. B. Osgood, Boston, Mass. (Closing his part of the discussion): I cannot begin

the discussion without thanking Dr. Smith and Dr. Taylor for this noteworthy contribution to our knowledge which they have given us.

One thing which you will appreciate if you read the detailed report of the cases is that when these patients become lax, they have a return of the symptoms. Up to this time there has been no definite scientific proof that the toxins themselves have a place in the actual cause of chronic arthritis. We have always assumed it. If you look through the literature I do not believe you will find it proved. Dr. Joseph Freiberg has been doing work on the injection of non-bacterial toxins from a case of dysentery and he has found definitely that it is possible to produce chronic changes in joints in rabbits exactly similar to arthritis by the injection of bacteria-free toxins. I think that last link has been forged in the chain.

Dr. Truslow suggests the term "sacro-iliac scoliosis". I believe the pain is commonly due to sacro-iliac lesions. There are some men who believe that sciatic pain can only be caused by sacro-iliac arthritis, but I do not think it is certain that sciatic pain is always caused by a sacro-iliac arthritis.

Dr. Wilson made an important point. We should be very careful not to lay too much stress on focal infection. I will have more to say about that in a moment.

Dr. Schauffler said he thought the cases I reported were simply the occasional cases. You will have to take what I say *cum grano salis* because this is only an experience of ten years, but it is my impression that these types comprise not the minority but the majority of the cases of sciatic scoliosis. If you will look through the literature you will find that any one who studies a large series of cases, as Bucholz did, has found it impossible to explain them on the basis of mechanics alone. I do not believe that the mechanical factor is as important as we have supposed and it was that inference that I hoped you would draw.

With regard to what Dr. Brown said, we work together and it is quite natural that our minds should run along the same lines. I believe the healthy thing to do is to reverse the practise of looking for focal infection first and then getting the patient well afterwards. Let us treat this condition of arthritis as a generalized disease. I believe focal infection, so called, is often due to exactly the same cause as the arthritis and that when the patient's resistance is increased the focal infection will disappear as well as the arthritis. A very illuminating instance which I will give you to close is this: At Canton is the Massachusetts Hospital School for Crippled Children. Many children were referred to this institution to have bad tonsils removed. Some forty cases with bad tonsils were referred for this purpose, but on a regime of fresh air and hygienic treatment preparatory to operation, they improved to such an extent that when they were ready for operation, in only four cases was it necessary for the tonsils to be removed.

# EARLY MOTION IN THE TREATMENT OF SEPARATION OF THE LOWER FEMORAL EPIPHYSIS

## Report of Case

BY ARTHUR S. GRISWOLD, M.D., BRIDGEPORT, CONN.

Separation of the lower femoral epiphysis is a relatively uncommon type of femoral fracture, often associated with nerve or vessel injury and frequently leaving a knee joint with more or less functional impairment, even after a prolonged period of treatment.

Within the last fifteen or twenty years great advances have been made in the treatment of diacondylar fractures and epiphyseal separations of the lower end of the humerus, partly due to the use of the acutely flexed position as advocated by Sir Robert Jones, and partly to the institution of early motion of the joint following complete reduction. Anatomically and functionally the knee joint closely resembles the elbow (excluding the radio-ulnar articulation); consequently it seems reasonable to conclude that the same improvement in results should be obtained in uncomplicated epiphyseal separations of the lower end of the femur.

Acute flexion in the treatment of these lesions was proposed as long ago as 1898 by Hutchinson and Barnard[1] and from time to time cases have been reported in which this method was employed.

Most recent books dealing with juxta-articular fractures also recommend varying degrees of flexion as the position of choice in which to maintain reduction. Plaster-of-Paris is used to hold this position, but attention is called to the discomfort caused by acute flexion in plaster. Gradual extension and new plaster-of-Paris is recommended after four weeks by Wilson[2] and Scudder[3], the cast being entirely removed after six to eight weeks. Cotton[4] has discarded the cumbersome plaster cast and substituted simple adhesive to maintain the acutely flexed position. He points out, however, the difficulty in getting full extension after union is solid, and therefore permits gradual use after only two to four weeks' immobilization. In the case here reported this principle of early motion was carried one step further, and as a result an unusually prompt and complete recovery ensued.

## CASE REPORT

Alexander Soltis, age eight, was first seen when admitted to the Orthopaedic Service of Dr. George W. Hawley at the Bridgeport Hospital on July 24, 1926. He gave a history of a fall through the bars of a hayrick three days previously, from which he had hung suspended by his left leg until rescued. Examination showed moderate swelling of the left leg especially in the region of the knee. Here there was a deformity strongly suggesting an epiphyseal separation of the lower end of the femur and this was confirmed by x-ray which showed almost complete forward displacement of the epiphysis.

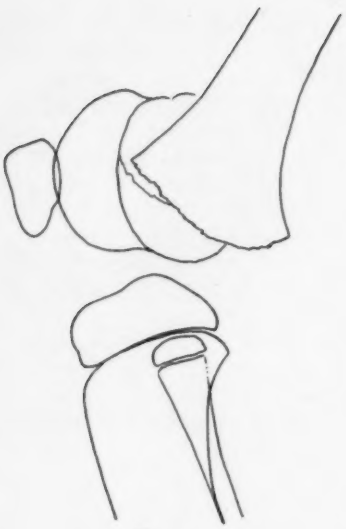

FIG. 1
Tracing of x-ray taken before reduction.

FIG. 2
Tracing of x-ray after reduction.

FIG. 3-A

FIG. 3-B

Range of motion in knee twenty-four days after reduction from:—
A. Hyperflexion to B. Full extension

Under ether anaesthesia the author followed exactly the same steps as in reducing a diacondylar fracture of the humerus, i.e., hyperextension to unlock the fragments, traction to overcome overriding, and acute flexion with strong downward pressure upon the upper pole of the patella (instead of the olecranon). Reduction proved to be fairly easy, the fragment slipping readily into place with a sensation of soft crepitus. This position of maximum acute flexion was maintained by adhesive exactly as in elbow fractures, though at that time the author was unaware that Cotton had already discarded plaster in favor of adhesive. No interference with circulation was noted and the epiphysis appeared firmly fixed in position.

The next day x-ray showed complete reduction of the displaced epiphysis. The swelling of the leg had appreciably subsided so that a few degrees of motion could be obtained within the limits of the adhesive. The youngster was perfectly comfortable and readily agreed to the proposal that he move the knee frequently through the five to ten degrees of motion permitted. The following day the adhesive on either side was slit and the knee extended ten degrees further, tape lacing being inserted in the adhesive to limit further extension, and active and passive motion encouraged. Every day the extension was increased a few degrees in the same way until at the end of the first week active painless motion to a right angle was secured. The necessity of completely flexing the knee (i.e., calf to thigh) after each motion was thoroughly impressed on the patient, and in this way a check was easily kept on any possible secondary slipping of the epiphysis. On July 5, 135 degrees of extension were secured, and by July 11 almost full extension was present. All adhesive was removed and ten pounds of traction applied intermittently for two days. On July 17, twenty-four days after reduction, the patient had full range of motion from hyperflexion to complete extension as shown in the accompanying photographs. The leg, of course, was still weak and he required support in standing and walking. He was discharged two days later, on July 21. When seen by his family physician on September 1, he was walking well with a cane, and continued to improve rapidly from that time on. When last seen by his physician, about June 1, 1927, the boy himself could not recall which leg had been injured.

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# THE MECHANICAL ACTION OF THE PERIOSTEUM IN FRESH FRACTURES

BY BEVERIDGE H. MOORE, M.D., F.A.C.S., CHICAGO, ILL.

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In all the text-books on fractures, and indeed in the literature in general on this subject, much stress is laid on the action of the muscles on the fractured bone, but no account at all is taken of any possible effect of the periosteum.

Anatomically the periosteum consists in young bone of three layers: an outer of interlacing fibrous bundles, a middle of fibro-elastic, and an inner of fine connective tissue bundles, between which are blood vessels and osteoblastic cells. In adult bone the middle and inner layers become fused into one in which the elastic tissue is still present. Since the periosteum is elastic it should have some effect on the fragments in a fracture, theoretically at least.

The observations on the effect of the periosteum presented in this paper were made during some experiments made on bones to determine if possible the variation in the types of fractures produced by different mechanical actions. Bones were secured through the courtesy of Armour and Company and fractures produced and studied, to see, if possible, what actually happens when a bone is broken. At various times more than a hundred of such specimens have been studied.

The bones chosen for the purpose were the leg bones of calves, technically known in the packing house as shin bones. These were chosen because they are typical long bones and are of a size comparable to human bones. These bones when obtained were fresh, that is, they were less than an hour away from the living animal. The skin and tendons had been removed, but the periosteum was intact. These bones were fractured by impact.

In studying these fractures, it was noted that in cases in which the bone was fractured transversely, the periosteum on the side opposite to the breaking force was always torn to a greater or lesser degree, usually from one-third to one-half the circumference of the shaft of the bone. The periosteal tear was always transverse to the long axis of the bone, and the periosteum was separated from the bone above and below the tear only a very short distance, if at all. The reason for this tear is simple. As the bone is bent during the breaking process the side toward which it is bent becomes relatively longer than the other, so that the periosteum is stretched beyond its elastic limit and ruptures, probably just after the fracture of the bone takes place, so the tear is transverse to the stretching force.

In addition to the transverse tear there were often, though not constantly, longitudinal tears extending from the ends of the transverse tear.

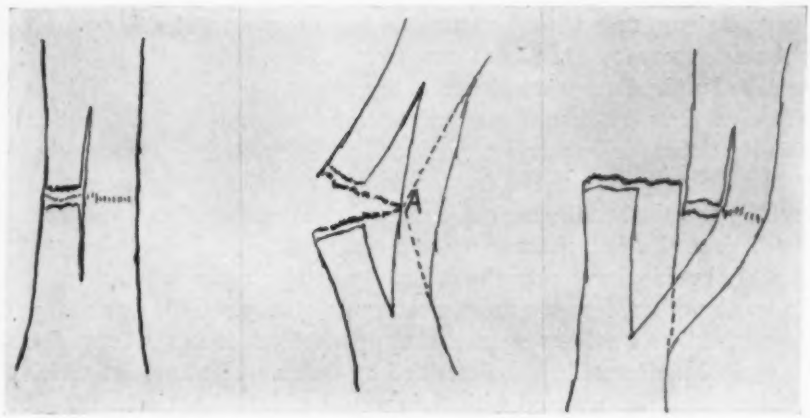

FIG. 1-A FIG. 1-B FIG. 1-C

Diagrammatic illustration of action of periosteum. Fig. 1-A, transverse fracture with torn periosteum on left, untorn on right. Fig. 1-B shows how the untorn periosteum is stripped from the bone. On bending the fractured bone, when the point *A* reaches the edge of the periosteal strip, sudden buckling occurs, due to the elastic pull of the periosteum. Fig. 1-C shows the resulting overlapping deformity. Traction in the axis of the bone results in locking of the fragments.

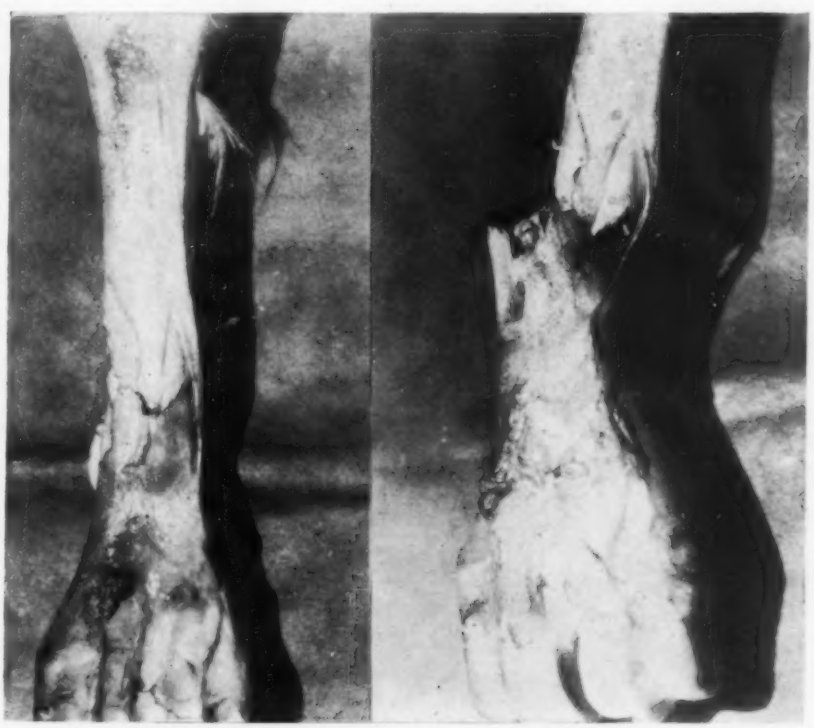

FIG. 2-A FIG. 2-B

On the left fractured bone showing untorn strip of periosteum. On the right the same bone showing the buckling and locking effect of the periosteal strip.

The periosteum near these longitudinal tears was separated from the bone on the side away from the transverse tear.

The longitudinal tears are probably accounted for by the fact that at this point the periosteum was not stretched beyond its limit, but as the bone bent the periosteum was stripped away from it. This mechanism could be clearly seen if the fragments of the broken bone were replaced carefully and the bending repeated slowly by hand. As this was done there was distinct elastic resistance up to a certain point, when the bone would suddenly buckle, increasing the deformity and usually one fragment would slip by the other, forming an overriding deformity. This was always accompanied by a further stripping of the periosteum from the bone, forming the typical periosteal bridge described by Ollier. The angle at which this buckling took place varied with the amount of intact periosteum. If this intact periosteum covered one-half of the shaft, more bending was necessary than if only a narrow strip remained. It always took place when the point of fracture on the side with the untorn periosteum moved forward to the lateral edge of the untorn periosteum. It was exactly such an effect as would be produced by a rubber-band applied longitudinally under tension on the fragments. In fact the sensation given to the hand is exactly the same as stretching a strong rubber-band.

After such an overriding deformity had been produced, attempts were made to reduce it by direct traction in the line of the long axis of the bone.

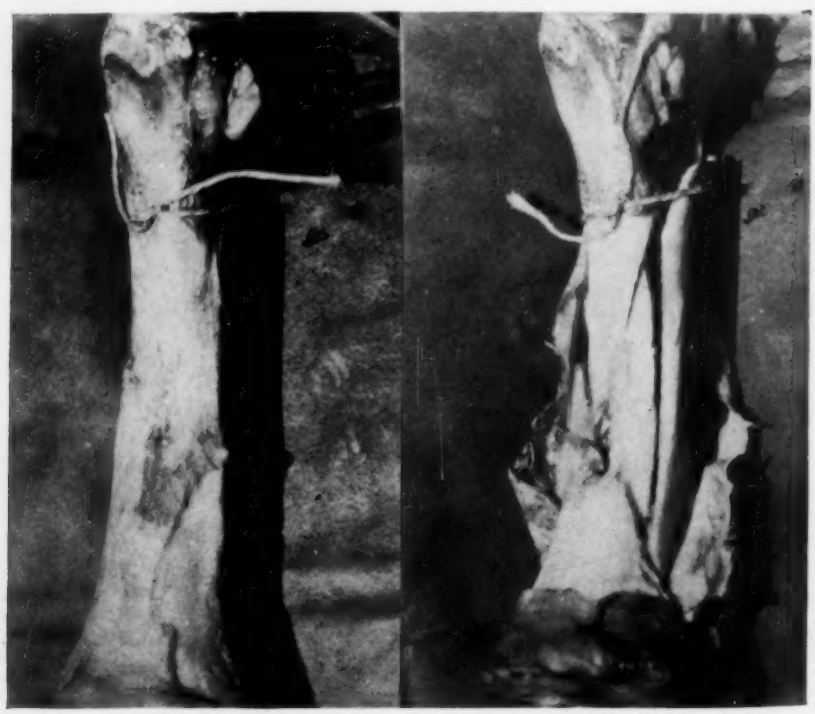

FIG. 3-A FIG. 3-B

On the left fractured bone showing very little deformity, due to splinting action of periosteum. On the right, same bone with periosteum reflected.

This was found to be very difficult, and if there was much irregularity of the bone ends, quite impossible by hand traction. In fact the harder the traction, the tighter the ends were locked together in the deformed position.

However, if the edges of the fracture on the side next to the intact periosteum were placed together, by bending the bone with the fragments at an angle, the fracture could be reduced perfectly by simply straightening the bone and the periosteum then acted as an elastic splint to hold the fragments in position. This is no new observation, but an explanation of the well known fact that a fracture is often most easily reduced by increasing the deformity and then straightening it. The elastic action of the periosteum seems to furnish an explanation of this fact.

When an oblique fracture was produced the effect on the periosteum was entirely different. Frequently no tear at all was produced and when one was present it was only a small longitudinal slit, situated at either end of the fracture and apparently produced by the sharp point of the bone fragment. The periosteum was often stripped from the bone for a considerable distance along the line of fracture. This stripping was apparently caused by the scissors-like motion of the fragments at the moment the fracture was produced.

In these cases very little deformity was found even when there was extensive comminution of the bone within the periosteum. The periosteum, being an elastic tube, acted as an efficient splint to hold the fragments together. However, there was constantly found a slight shortening of the bone from one-fourth to one-half inch, depending on the amount of periosteum stripped from the bone. A pull of from thirty to forty pounds was necessary to restore the bone to its original length. It is to be remembered that in all these cases the pull was applied directly to the bone and not through the medium of adhesive plaster applied to the skin over the muscle as in the ordinary Buck's extension. In this case much of the pulling force is not applied to the bone at all.

To determine the elasticity of the periosteum a strip six inches long and one-half inch wide was detached from the bone. This was firmly held at one end and weight applied at the other. It was found that a pull of six pounds would produce one-fourth inch lengthening. Fifteen pounds would produce one-half inch lengthening. It is to be remembered that in dealing with fractures one is probably never pulling on a six-inch strip, but one much shorter, so that the limit of elasticity is much sooner reached.

## CONCLUSIONS

In transverse fractures the elastic pull of the periosteum is an additional factor to muscle pull in producing angular and overriding deformity. It also tends to lock overriding fragments by its mechanical action under direct traction. It also by its elastic action tends to cause angular deformity, if reduction is not anatomically perfect. However, when anatomically perfect reduction is obtained, this elastic action of the periosteum tends to maintain it. Therefore, manipulation which will take advantage of these properties of the periosteum is advisable.

# PHYSIOLOGY OF MUSCLE INNERVATION WITH SPECIAL REFERENCE TO THE INFLUENCE OF THE SYMPATHETIC SYSTEM*

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The problem of the relation of the sympathetic system to skeletal muscle function has been the subject of much investigation and discussion. It came into special prominence during the tour of American and British clinics by Hunter and Royle (1924), unfortunately terminated by the death of Professor Hunter in the course of the tour.

The basic contention of Hunter and Royle, that spastic paralysis can be alleviated by extirpation of the sympathetic innervation to the affected muscles, was doubted by a number of clinicians and physiologists, but seems to have been firmly established (at least for a considerable proportion of cases) by the striking positive results of Stewart[1] (1927). The theoretical explanation proposed by Hunter and Royle, appears, however, to be untenable; consequently some alternative explanation is to be sought.

Before turning to the quest for alternatives the reason for rejecting the theory of Hunter and Royle is to be considered. Briefly, their theory rests on a conception of skeletal muscle tonus which cannot, in the opinion of most specialists in the field, be reconciled with the well established facts of muscle anatomy and physiology.

The sustained and relatively gentle tension of the muscles (mainly extensors) which constitutes tonus was explained when explanations were first attempted (See Fulton[2], 1926, for historical survey and extended discussion of skeletal muscle tonus, with full bibliography.) as due to slight contraction of the muscles as wholes. With the discovery that individual muscle fibers contract in an "all or nothing" fashion, *i.e.*, to the extent of their capacity at the moment or not at all, the above simple explanation was seen at once to be untenable, and various alternative theories were proposed to account for tonus. One of these, the one on which Hunter and Royle based their explanation, depends on Langelaan's conception of plastic fixation, *i.e.*, that certain muscle fibers (The evidence is clear that the "red" fibers were in mind at first.) have the contractile property in different form from ordinary muscle fibers, their sarcoplasm being able to contract and then to remain fixed with little or no further expenditure of energy. Furthermore, the fibers possessing this property are presumed to have sympathetic innervation, by which the sarcoplasmic contractions are evoked.

A number of facts weigh conclusively against the above conception.

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For one thing, anatomical study has shown clearly that the innervation of red fibers in mammalian muscle is essentially similar to that of pale fibers, both types having ordinary somatic innervation, and both, in some instances at least, sympathetic innervation as well. Furthermore, red fibers have been proved to contract upon ordinary somatic nerve stimulation in the same manner as pale fibers, although less rapidly. A third fact of great significance is that no one has yet satisfactorily demonstrated contraction of the plastic fixation or any other type in any vertebrate upon stimulation of sympathetic nerves alone.

An alternative theory of tonus which has no place for plastic fixation is that tonus is maintained by ordinary contractions of muscle fibers, both red and pale, working a few at a time in rotation, thus minimizing fatigue. Facts in support of this theory are: that the maintenance of tonus actually requires an expenditure of energy comparable to what one would expect if the tonus is maintained by ordinary contractions and greater than would be anticipated in plastic fixation; that under satisfactory conditions action currents can be demonstrated in muscles in tonus, indicating that some of their fibers are contracting in ordinary fashion; finally, that the inhibition of tonus (strictly of the "stretch reflex" which underlies tonus) takes effect as rapidly as does the relaxation of muscle following ordinary tetanic contraction, contrary to what one would expect were the tonus a matter of sarcoplasmic fixation.

The inadequacy of the evidence favoring the plastic fixation theory of tonus, together with the adequacy of the somatic contraction theory, inclines nearly all students of the problem to accept the second and reject the first, thus ruling out the view that spastic paralysis is basically an exaggerated tonus maintained through the sympathetic system. The benefits following ramisection are not then to be explained as due to abolition of such a tonus. What alternative suggestions can be offered?

To clarify the problem it must be recognized that spastic paralysis is essentially an exaggerated tonus, although not now conceived to be maintained through the sympathetic system. The whole matter of tonus has been systematically investigated by Sherrington of Oxford and his collaborators. These workers have shown that a definite and fairly simple reflex underlies all tonus manifestations. This, which Sherrington designates the *myotatic reflex*, has its origin in sensitive structures imbedded among the muscle fibers themselves and stimulated whenever the fibers are stretched. These sensitive structures connect with sensory (proprioceptive) neurons, and the impulses set up are conveyed to the cord and back over motor neurons to muscle fibers in the vicinity of the point of stretching. Thus, whenever any muscle or part of a muscle is stretched, reflex tonus of the same muscle or muscle portion is set up, tending to counteract the effect of the stretching. That a mechanism of this sort is involved in spastic paralysis is clear from the familiar observation that the muscles are often flaccid when the paralyzed parts are supported in positions of no tension, but become tense when movements of the patient put them on the stretch.

If tonus and the exaggeration of tonus seen in spastic paralysis are thus maintained by the somatic nervous system, what has the sympathetic system to do with them, and particularly why should ramisection be of any benefit? The answers to these questions are not yet known, but some suggestive observations are on record which may help toward arriving at them. The observations referred to are those of Orbeli and his students, working in Leningrad (Petrograd). These observers have found that if a skeletal muscle (frog) is stimulated rhythmically through its somatic nerve until signs of fatigue begin to develop, and then, while the somatic nerve stimulation is continued, the sympathetic innervation is also stimulated the contractions improve in height, indicating that sympathetic stimulation has in some way affected the muscle, causing it to perform better than before the stimulation was applied. The effect was proved not to be due to changes in the circulation through the tissue, but to be a direct action on the muscle cells themselves. The effect is usually somewhat delayed, suggesting that the action of the sympathetic may be on the chemical organization of the muscle tissue, resembling thus the effect of the same innervation on the heart, as Orbeli points out.

The possible connection between the above experiments and the beneficial effect of ramisection on spastic paralysis is purely speculative, yet one may perhaps venture to suggest that a muscle deprived of opportunity to function actively through impairment of its upper neuron connections, yet continuing to receive "trophic" influences through the sympathetic system, might conceivably pass into a state leading to accentuation of its tonus, which is maintained, as already pointed out, by reflexes localized within itself. Ramisection, by removing the source of constant "trophic" stimulation, might enable the muscle to recur to a metabolic state better adapted to its enforced quiescence, a state in which tonus ceases to be exaggerated.

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## DISCUSSION

Note: In the following discussion reference is made to a paper also presented at the Annual Meeting by Dr. Steele F. Stewart, entitled, "End Results of Ramisection in Spastic Paralysis". This was published in the *Journal* for October 1927 (IX, 724). —*Editor*

Dr. J. E. Stewart, St. Louis, Mo: I feel that I am personally ill fitted to discuss a paper on ramisection. In the first place my actual experience with the procedure is limited to what I have seen done in Los Angeles and with what Dr. Steele Stewart was good enough to show me. In the second place, what I have read has convinced me that

I do not understand the physiology of the sympathetic nervous system and particularly its relation to spastic paralysis. What I have heard and seen in Los Angeles and in Dr. Martin's talk has interested me very much, however, and I think stimulated a desire to look into it more thoroughly and see if I cannot comprehend it. I came West convinced from what I had read that the operation of ramisection had been tried in various sections of the country and had been condemned in almost every place, though by men who were capable of performing the operation, but possibly not of selecting cases to be operated on. Certainly Dr. Stewart in his splendid abstract of the procedure and what he showed us in Los Angeles has convinced me otherwise. He showed a number of cases that had apparently a very striking improvement. I saw him do the operation and I assure you he did as nice and careful a dissection of the sympathetic rami as one could see. I have also become interested enough in it so that I am going back to Los Angeles and see if Dr. Stewart will be good enough to show me some more of the work and some more of the cases, and I believe that after seeing his work I may try it myself. I believe that it is quite worth while after a man has worked it out as carefully as he has done, to go ahead with it and demonstrate to us what may come of it. I do not believe it is a thing that can be handled promiscuously even by orthopaedic surgeons. It seems to me that the selection of cases is very important and one cannot learn how to select cases without having seen the results in certain types of cases after operation, but I believe if a few selected men who are capable of doing this work would go along with it, we may get a good deal out of it.

Dr. Thomas A. Stoddard, San Francisco, Calif.: I have been interested enough in spastic paralysis to spend two weeks with Dr. Royle in his clinic in Sydney, Australia, about eighteen months ago, assisting him there, in operating on two spastic cases. Returning to San Francisco, I found a case of spastic paralysis in the Children's Hospital that had been perplexing the attending surgeons. It was a congenital syphilitic case, the mother showed a triple plus positive Wassermann. The boy was ten and a half years old; he had a useless left arm and a defective left leg. Believing in Dr. Royle's explanation for the production of spasticity I decided that it would make no difference whether the permanent lesions were from syphilis or some other cause, and they could be relieved by cutting the sympathetics to the area involved. His left arm was useless. We could do it no harm. We operated on his left cervical region first and got a surprisingly good result. I am now going to show you a moving picture of this result; this was my first effort in making moving pictures in this type of cases. I believe we have a result here that will be lasting.

Following the operation I had a thermometer placed on the limb on the operated side and then on the limb of the unoperated side every six hours for a couple of weeks. During the first few hours we got a very marked difference in the temperature; finally at the end of a couple of weeks this difference had been reduced to about two degrees.

Royle states that as long as he gets good results following his operations, he is satisfied to let the laboratory men work out the theory of what has happened.

I was led to do this kind of surgery through my observations of Dr. Royle's results. His theory of the causes of spasticity, and what effect the operation has on the muscles, is up to the laboratory men to verify or explain. While we can effect these changes let us do it. We are not putting the youngsters in any particular danger. One of the best changes in this boy's case was in his ankle movements. Remember this boy's mother had a triple plus positive Wassermann and the boy had been having extensive antiluetic treatments before operation. I stopped the medication temporarily as soon as I prepared to operate, so as not to confuse the effect of medicine and surgery given at the same time.

Most of these patients will tell you that they can do things more easily than they did before. One man, thirty-four years of age, had had all kinds of operations which were more or less deforming, and his particular complaint to me, following ramisection, was that he could not show results that could be pictured. He claimed that he could do things more easily, and was satisfied.

Dr. H. W. Orr, Lincoln, Nebr.: Perhaps I may add just a word to the discussion. First of all, I want to thank Dr. Stewart and Professor Martin for their very valuable contributions. Through the courtesy of Dr. Steindler a few months ago I had the pleasure of seeing Dr. Royle do one cervical and two lumbar ramisections. I saw many of his moving pictures showing the clinical results and heard him talk at considerable length about his work and about his present views. One of the things that impressed me was that, partly as a result of the critical experimentation and investigations that have been made, Dr. Royle has been driven to the point where he himself does not feel sure of what happens in these cases, but something has been done which definitely improves these patients from a clinical standpoint.

I am not at all competent to discuss this from a physiological or experimental standpoint, but there are certain things that occur to me from a clinical standpoint. Certain of these cases come to us very soon after mechanical injury or inflammatory change in the cerebral cortex and with spastic phenomena in the extremities that develop at once. This seems to indicate that there has been some immediate change in the muscles or in the peripheral nerves or in the circulation of the extremities involved. If there has been no such change then we have a clinical problem that appears to be a purely reflex phenomenon, the result of the removal of cerebral control in the extremities. If in the affected extremity we have a muscle mechanism which depends upon certain nerves that stimulate the muscles to contract and certain others that stimulate the muscles to let go, and if between those two we have a sympathetic influence that may be removed by operation upon the sympathetic rami, then release of this sympathetic control gives us the result that we see when this operation is performed. As far as I have gone with ramisection, that appears to be the case. The cases I have done show exactly the same phenomena as shown here.

One point should be mentioned in connection with Royle's comment on his work. He says his worst critics have been those who, because of different technique, have failed to obtain the results he has. He points out that in the cervical operation many operators fail to go low enough to get the lower part of the plexus. In the lumbar operation they fail to go high enough. I think those rules are important and must be observed. The operation is not an easy operation. In the lumbar region it is very difficult to get all the roots. It is an operation, which, however, is not too difficult if properly undertaken and properly carried out.

Dr. E. A. Rich, Tacoma, Wash.: It would be presumptuous of me to discuss the physiological aspects of a matter like muscular tone as presented by Professor Martin. When Professor Martin concluded his talk upon tonus he had presented to us the last word that is to be said upon this one matter of physiology.

As orthopaedic surgeons how does this matter of tonus interest us? From our view-point, of what importance is muscular tone? We know that tone is a state of latent and permanent contraction of a normal muscle at rest,—this when we are talking about normal tonus. But normal tonus only interests us as a gauge or a measure for the abnormal. We have a variety of pathological conditions that alter this matter of tone. For instance, cerebral disorders give us conditions of hypotonus, while the spastic conditions under discussion present us with a state of hypertonus. We have learned something about tone from our general experience but we have no true measure for it. As yet we have no adequate apparatus to definitely guide us as to degree.

When Professor Martin was working with Dr. Lovett in Vermont doing exhaustive investigations in the epidemic of 1914 he devised the use of the spring balance to test muscles not entirely paralyzed. We were then given a measure of *muscle strength*, but he, nor anyone else, has ever given us anything to gauge muscular tone. The only recourse we have is manual palpation. In making our examinations we feel the limb and roughly estimate whether the involved muscles are one hundred per cent. or ten per cent. in tone. The method is crude and we sincerely hope that physiologists before they stop will devise something that is better than this guess work and give us an instrument to measure muscular tonus.

We were glad to get Dr. Stewart's definition of spastic paralysis. In the Far West we see too much of it. It seems as though this were the refuge for the spastic cases. In taking histories we find that many of our patients come from the Dakotas and other mid-western states. We sometimes wish that we had another, more distant frontier.

Spastic paralysis is a complicated constitutional disorder accompanied by a great deal more than just the muscular conditions of the torso and the limbs. We know that spastic paralysis is a diffuse, irregular and expansive discharge of impulses into the muscles in certain individuals who have or who are going to have mental changes. We sometimes see children of eight or ten whose minds appear one hundred per cent. normal, but, mentally, does that normalcy often hold true or continue? My experience is that if we watch these individuals for five or ten or fifteen years there usually develops some mental deterioration. One looks for the reason and it is easy to believe there is a connection between the long continued muscular contraction and the brain changes.

I think that as orthopaedic surgeons we have already gone a long way toward the treatment of the local muscular states. This demonstration today, the work of Stoefel, Hunter and Royle during the past ten years, have resulted in infinite good for the patient and much experience for the profession. Time alone will tell whether local results are to be permanent or not. However, one truth is established, namely, that during the period when the muscles are thrown out of commission by any of the mentioned procedures there follows a beneficial period of complete rest; there is restitution and there seems to be tonic improvement. Perhaps we have got as far as we are going to get with the spasticities until we attack the antagonistic muscles. As far as I know we have paid scant attention to the antagonists. Is it possible for us to look to the neurologist for any help? Can we hope for any sort of neurological development or any form of neurological education that might attack the problem from a different angle?

We must thank Professor Martin for his contribution. Anybody who throws any light upon so baffling a subject as spastic paralysis is certainly a help to humanity.

Dr. Leo Mayer, New York, N. Y.: I am particularly anxious to know in which type of case this operation has proved to be of particular benefit. I hope Dr. Stewart in his closing discussion will tell the exact indications for the operation so that when we go home and try this, we may select those cases which are most favorable and most likely to give good results.

Dr. Steele F. Stewart, Los Angeles (Closing the discussion): I have been asked how I choose my patients for ramisection. Patients are selected on the following basis:

1. Intelligence. I refuse to operate on all patients having an intelligence quotient of less than fifty per cent., as lower intelligence prevents satisfactory cooperation and the patients are very likely to be obstreperous and hypersexual and had better be left in bonds.

2. Rigidity as distinct from contracture. I find the following tests to be of value in determining this point and it may be confined to one joint or muscle:

(a) In the upper extremity the very slightest rigidity may be a marked hindrance and the most gentle comparative examination is essential. Adiadokokinesia may be the only sign.

(b) In the lower extremity at the knee joint several tests are of value and all or only one test may be positive: (1) An exaggerated reflex is of no significance; (2) A knee jerk which does not smoothly and instantly return to its original position, i.e. it is maintained or hung up; (3) Rapidly repeated knee jerks produce an increasing extension of the knee; (4) Shortening phenomena as shown by holding the knee in extension and while the patient is completely relaxed the leg is suddenly released; instead of instantly returning to a full degree of flexion it is caught and maintained in a certain degree of extension.

(c) At the ankle we observe one or more of the following: (1) The stance.—Gait test is the most important. I believe this was described first by Weir Mitchell a half century ago. A patient will stand fully on both feet, but the instant he begins to walk the foot goes into an equinus, or the heel may touch the ground for a mere instant.

(2) When the foot is dorsiflexed beyond a right angle, held so for a time and suddenly released, the anterior tibial tendon will be found to become taut.

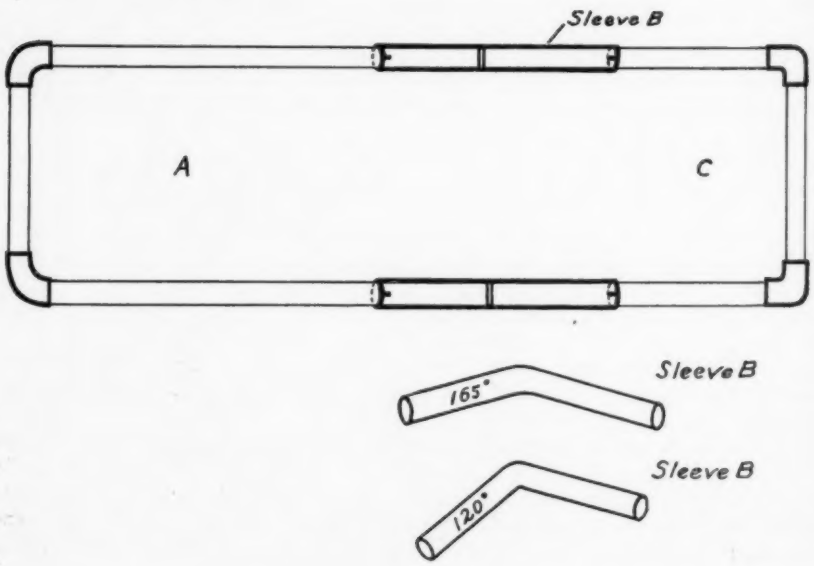
3. Active motion should be observed pre-operatively if a good result is to be expected.

Involuntary motions aside from the ataxic hand and finger motions have not been experienced.

## AN EASILY PORTABLE CONVEX FRAME

BY PAUL C. COLONNA, M.D., NEW YORK

An ordinary Bradford frame which has been divided, *A* and *C*; and fitted with a sleeve *B*, which is made in straight and bent forms as shown in the drawing below, has been found very useful in the treatment of spinal deformities. When for some reason the patient must be treated at home, the unassembled frame is much less cumbersome and awkward to transport than the ordinary frame, can be easily assembled, and any degree of convexity desired can be obtained within a few minutes, depending upon the angle of the sleeve-piece used. The usual canvas cover is applied over the frame.



# DISLOCATION OF THE HEAD OF THE RADIUS. SUGGESTION FOR A NEW OPERATIVE PROCEDURE

BY HENRY MILCH, M.D., F.A.C.S., NEW YORK

In the American Journal of Surgery[1] for September, 1926, the writer ventured to suggest a new operative procedure for the treatment of the dislocation of the lower end of the ulna. The principles proposed in that communication were to the best of his knowledge new in the field of reconstructive surgery and consisted, essentially, in the formation of a free fascial graft sling. Within this sling, the head of the ulna could rotate in a manner similar to that in which the head of the radius normally rotates within the orbicular ligament. Since that time, the principles then tentatively proposed have been proven to be possible of actual surgical application with gratifying results. At a meeting of the Berlin Surgical Society held March 14, 1927, Klapp[2] presented two cases of habitual dislocation of the distal end of the ulna treated with success by the operative principles which the author had suggested. In the light of these satisfactory results, he may possibly be pardoned for suggesting the further application of these principles in the treatment of dislocation of the head of the radius.

The radius and ulna are the only two bones in the body which lie parallel to one another, and which rotate about a common axis to produce the movements of pronation and supination. This common axis of rotation, oblique to the direction of either bone, is determined by the center of the capitulum of the radius and the center of the head of the ulna. This line extended falls directly upon the center of the head of the humerus and may be considered as the axis of rotation of the whole of the upper extremity. The rotation of the humerus about this axis explains the auxiliary function of the shoulder in the motions of pronation and supination of the hand. Leaving out of consideration these rotatory motions of the shoulder and of the lower radio-ulna joints, the action of pronation and supination will be considered for our purpose as occurring in the superior radio-ulna articulation.

The superior radio-ulna articulation is a pivot joint comprising the head of the radius and the lesser sigmoid cavity of the ulna. The main bond of union of this joint is the orbicular or annular ligament which is described in Spitzka's edition of Gray's Anatomy[3] in the following manner: "The orbicular ligament is a strong, flat band of ligamentous fibers which surrounds the head of the radius and retains it in firm connection with the lesser sigmoid cavity of the ulna. It forms about four-fifths of an osseofibrous ring, attached by each end to the extremities of the lesser sigmoid cavity, and is smaller at the lower part of its circumference than above,

by which means the head of the radius is more securely held in its position. Its outer surface is strengthened by the external lateral ligament of the elbow and affords origin to part of the supinator brevis muscle. Its inner surface is smooth and lined with synovial membrane. The synovial membrane is continuous with that which lines the elbow joint."

The sole motion of the head of the radius in the radio-ulnar articulation is one of rotation. As the head of the ulna rotates in one direction, the head of the radius rotates about the same axis and through the same arc but in an opposite direction. Its limits of rotation are determined by the tension on the ligaments of Denucé, a short quadrilateral band of fibers connecting the head of the radius with the lesser sigmoid cavity, by the interposition of the soft parts of the forearm, and by the tension on the ligaments of the inferior radio-ulnar articulation. Apart from this motion upon the ulna, the head of the radius enters into a flexion and extension motion with the capitellum of the humerus. In this arc of its motion, the head of the radius is retained by the capsular ligament and especially by the external lateral ligament extending from the humerus to its insertion into the fibers of the orbicular ligament with which it is continuous. For the proper carrying out of these four motions, the firm fixation of the radial head and consequently the integrity of the orbicular and the external lateral ligaments are essential.

Without attempting to consider in detail the pathology or the pathogenesis of the different varieties of radial dislocation which have been described, it may be stated that in practically all cases there have been constant injuries to either the orbicular or the external lateral ligaments or both. These injuries have varied from mere stretching to complete rupturing of all the ligamentous tissue. While not absolutely essential to the development of a dislocation, tearing of the orbicular ligament is one of the most constant of the pathological findings. If the dislocation is reduced early, either by closed or open methods, no difficulty is usually encountered. If, however, the reduction is delayed a matter of five to six weeks, the difficulties of reduction become immeasurably increased. The torn ligament atrophies or becomes adherent to the radial head and interferes with reduction. If the reduction is delayed longer, over months or years, the tribulations of the surgeon increase. Arthritic changes occur in the sigmoid cavity and in the elbow joint. In the extreme case of Dr. Larkin's patient reported by Stimson[4], there may even occur so excessive a growth in the length of the radius as to completely preclude the possibility of reduction.

Dislocations of the head of the radius usually occur as the result of violence, but they may develop from congenital causes or following disease of the joint tissue. They form, according to Stimson, from one and four-tenths to four per cent. of the total number of dislocations seen at large clinics, and are consequently far from being uncommon. A variety of different methods have been employed in their treatment. In the fresh cases simple, closed reduction is usually sufficient to insure a cure. In

some cases, however, reduction is impossible, and recourse must be had to open operation. Speed, in his volume on fractures[5], reports on a fresh dislocation of the radius in which arthrotomy was necessary. The orbicular ligament was torn away from its attachment for about three-fourths of its circumference. In the cases seen and treated after the lapse of some time, almost any complication and difficulty in reduction may be encountered. For these, simple reduction is usually insufficient and operation is indicated. Leaving out of consideration those gross malformations of the bones of the elbow, consequent to the dislocation, the operative procedures have, in the main, consisted of simple arthrotomy with attempts at repair of the torn ligaments or of resection of the head. Where the ligament can be repaired, this procedure is, of course, ideal. On the other hand, to be forced to resection of the head because of the mutilation of the ligamentous structures seems to be so foreign to the spirit of modern reconstructive and reparative surgery, that some effort should be made to obviate this unpleasant necessity.

In the operation here suggested an attempt is made to restore the function of the torn annular ligament. A fascial graft is cut in such fashion that while one part of it will function as a new orbicular ligament within which the head of the radius may freely rotate, the lateral extension will operate to provide a reenforcement to the injured external lateral ligament. By appropriately tightening the fascial sling so formed, the head of the radius is kept in contact with its normal articulation in the lesser sigmoid cavity of the ulna. In performing this operation, it is recommended that the anterior incision be made first. Through this incision, a fairly accurate estimate of the pathological situation can be made and either simple suture or

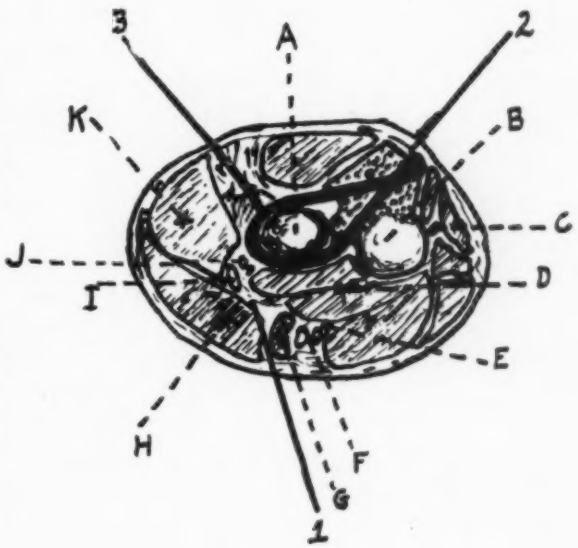



FIG. 1

Schematic cross section of the forearm at the level of the radial neck. Showing the important anatomical landmarks, the sites of incision and the relative position of the fascial graft at the close of the operation.

1.—The anterior incision; 2.—the posterior incision; 3.—the external incision.

A.—The head of the radius; B.—the ulna; C.—the ulnar nerve; D.—the brachialis anticus muscle; E.—the median nerve; F.—the brachial vessels; G.—the biceps tendon; H.—the brachioradialis; I.—the posterior interosseus nerve; J.—the radial recurrent artery; K.—the extensor tendons.

FIG. 2

Showing approximate shape of fascial graft.

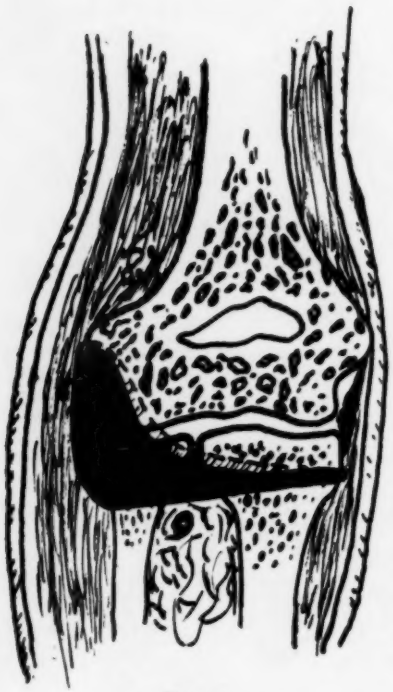


FIG. 3

Sagittal section showing relative position of the bones and the anterior half of the fascial graft at the termination of the operation.

the more complicated plastic procedure on the ligaments may be undertaken as the conditions warrant (Fig. 1).

The anterior incision is made in the bend of the elbow at the level of the head of the radius, just external to the tendon of the biceps which can be easily palpated. After division and ligation of the median cephalic vein, the muscle planes are separated and the biceps is retracted internally, thus protecting the brachial artery and its branches as well as the median nerve. In the groove formed by the biceps and the brachialis anticus internally and the brachioradialis externally, the radial recurrent artery, the musculospiral nerve and its large terminal branch, the posterior interosseus nerve, are found. These are retracted externally along with the brachioradialis muscle, exposing the anterior part of the superior radio-ulnar articulation which lies at the bottom of the wound. At the outer edge of the brachialis anticus insertion into the under surface of the coronoid process of the ulna, a small drill hole in the ulna is made directly backwards to the subcutaneous surface of the olecranon. This surface is exposed by a small incision on the posterior surface of the arm and through it a guide suture is passed to the anterior wound.

An incision is now made along the outer side of the elbow, extending from the external epicondyle to slightly below the edge of the radial head. Both of these bony landmarks are superficial and except in very stout patients can always be located easily. Behind the posterior border of the radial head, a small portion of the outer surface of the coronoid process of the ulna covered by the attachment of the supinator brevis is seen. The muscle is split in the direction of its fibers and at a point just beneath the lesser sigmoid cavity of the ulna a drill hole in the ulna is made in a backward and inward direction. By keeping the drill pointed posteriorly, any serious danger to the ulnar nerve, which lies in a somewhat more anterior plane, is avoided. From the posterior wound, a guide suture is passed through the drill hole to the external incision. A tunnel is next bored from the external incision beneath the supinator brevis and the extensor group

of muscles to the anterior wound previously made. A guide suture, encircling the neck of the radius is passed through from the anterior to the external incisions.

A strip of fascia lata twelve to fifteen centimeters long and four to five centimeters at its greatest width is cut in the shape suggested in the accompanying sketch (Fig. 2). The fascial wound is closed by an assistant. By means of the guide sutures previously passed, the graft is made to encircle the head of the radius in such a manner that the broad diameter of the graft lies between the epicondyle and the head of the radius, with the smooth gliding surface toward the joint. The free ends are drawn through the drill holes in the ulna. At the sites of their emergence on the posterior surface of the olecranon, they are crossed and sutured to the periosteum and to themselves. The posterior wound is closed. Through the external incision, the upper edge of the fascial graft is sutured to the tip of the external epicondyle to act as an external lateral ligament (Fig. 3). The wound is then closed. The anterior wound is closed and the arm immobilized in a light plaster cast.

It is realized that the procedure here suggested for the reconstruction of the superior radio-ulnar joint is much more complicated than the analogous operation suggested for the inferior articulation. Nevertheless, despite the more complicated anatomical arrangement and the necessity for opening the elbow joint, it is believed that, in the failures of simpler procedures, this operation should at least be considered before proceeding to resection of the head of the radius.

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# TECHNIQUE IN THE USE OF GRAFTS IN CASES OF NON-UNION

BY FREDERIC J. COTTON, M.D., BOSTON

This note was originally written in reply to a query from a man who had chanced to see results in several of the cases.

No claim is made for any originality in the matter. Enough work has been done—mine a small part of it—to establish an understanding of repair processes and to end the fetish worship of the periosteum. Most surgeons know of this.

What is less well understood is that the centre of a graft dies or becomes inert, and only the surface can help in repair. Consequently what one wants is *surface area* and that means cutting up the grafts!

Massive grafts, as inlays or as pins, have their use as mechanical devices, but their available *bone-producing surface* is very small indeed.

The routine followed in clean non-union cases is to expose in such a way as to give plenty of room, but also a good covering, with the skin incision well away from the actual scene of work. The false joint is cut down on, and cut out, and bone is removed from each fragment well back beyond the point where the bone structure is fibrosed. This means cutting back into properly nourished bone, but does not usually mean cutting back into the medullary cavity.

An effort is made to arrange things so that the opposing surfaces shall be somewhat concaved, and not too smooth. On the back of the bone care is taken to leave enough fibrous tissue to act as a strap. The rest of the fibrous tissue everywhere is removed pretty freely. Periosteum is saved and stripped up a bit, but in fact it does not make much difference what is done to the periosteum as it is usually not an important factor in the repair of these old cases.

The grafts are obtained from a rib, or more usually from the flat surface of the tibia on the inner side below the knee, where a good deal of bone may be taken out without damage, and where the bone, though firm, is more or less spongy and better adapted for growing as a graft.

The actual surface bone is taken off in a thin layer, with periosteum attached, to be used later. The mass of bone, without periosteum, is broken up into small fragments which will hardly average one-third of an inch in the longest diameter. The cleaned out site of fracture is then opened up, by bending the limb, the cavity filled up with these chips, pressed in, and the limb straightened so that they are held under pressure. This is where the use of the "strap" comes in, the fibrous tissue left on one side, and in this way the grafts are held *in contact, under some pressure.* Then in the vicinity bridging the gap, are laid the slivers that have periosteum attached, to do what they will to help. The wound is then closed

without drainage, and rather early, often within three weeks, diathermy is started. Very soon after that, if the case is a thigh or leg, a walking splint is applied, so as to get the advantage of stimulation, not only from diathermy, but from use as well.

It goes without saying that one must do decent apparatus work to maintain fixation. The results have been remarkably good. The author has used this method in a good many cases within the last five years, and can recall but three failures—one of the ulna, unexplained; two of the humerus, just above a partly stiffened elbow, in which the impossibility of real fixation was the factor. The rest, including several femur cases, are all solid.

In these cases of non-union the writer has practically abandoned all other forms of graft. There is no doubt, of course, that other forms of graft will do the work part of the time, or that refreshed fractures without grafts will unite in some cases, but until this technique was worked out as a routine there were failures enough to make the writer very uncertain of results.

# RICKETS OF THE LOWER EXTREMITIES:

## Its Relation to Genu Valgum and Static Flat-Foot*

BY C. ULYSSES MOORE, M.D., M.SC., F.A.C.P., PORTLAND, ORE.

Rickets may be defined as a perversion of metabolism, characterized by an inadequate assimilation of certain minerals, and affecting successively the nervous, muscular and osseous systems.

The skeletal signs of rickets appear in the various bones at the time of their most rapid growth. Consequently the chief manifestations during the first six months of life are in the flat bones of the head, as craniotabes; during the first year in the bones of the chest, as costomalacia, rosary, and Harrison's Groove; during the second year in the extremities as enlarged epiphyses, genu valgum or varum and pes planus. At puberty the bones of the extremities have a second period of rapid growth, thus fostering a recurrence of rachitic manifestations. Static flat-foot is often noted for the first time at this age.

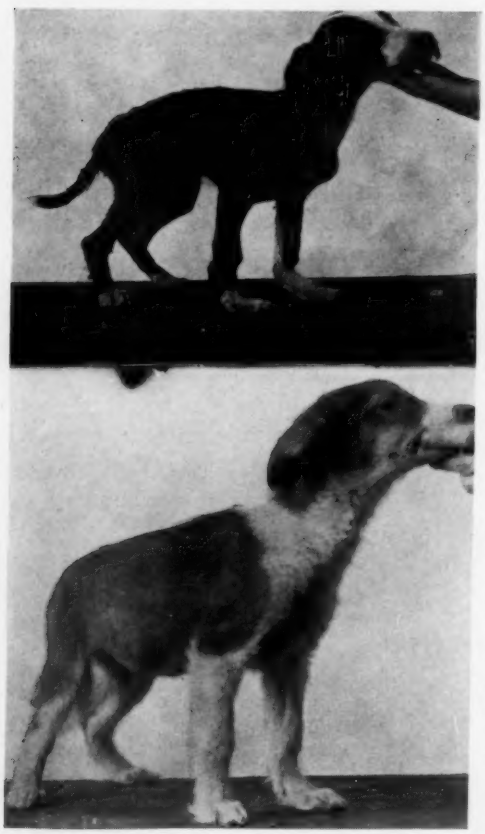


FIG. 1

Photographs of puppies illustrating differences between the normal (lower) and the rachitic (upper). The rachitic dog has noticeably enlarged and angular epiphyses and flattened feet.

Rachitic lesions produced in puppies and rats in our research laboratory at the University of Oregon Medical School, well illustrate some of these skeletal defects.[1] Figure 1 contrasts a rachitic dog with its normal litter mate. The joints of the former are enlarged and angular and the feet are flattened out when his weight is upon them. The normal dog is more "on his toes" both literally and figuratively.

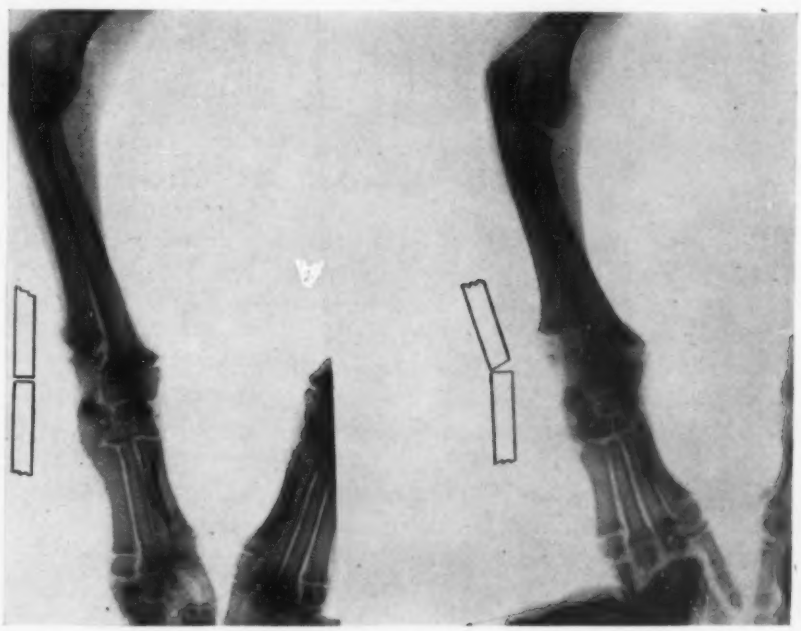
Roentgenograms (Fig. 2) of these animals demonstrate the difference in the deposition of

*Read before the Portland City and County Medical Society, Portland, Ore., Feb. 23, 1927.

calcium. The parallel ends of the bones at the knee joint in the normal dog are in marked contrast to the angle formed by the ends of the rachitic bones in the other animal. This condition is accounted for by the sponginess of the epiphyses and the remoteness of well calcified bone from the articulating surface. When weight is imposed, this loose-jointed condition of the knees results in genu varum or genu valgum, depending upon whether the ossified portions meet upon the lateral or the medial side. Likewise when the bones of the foot are so loosely connected, how futile is any attempt of the fascia and muscles to maintain the arch.

In bipeds the situation is more complicated than in quadrupeds, because the bone construction is less simple. At the knee the epiphysis of a young child is irregular, is separated from the diaphysis and lies at a considerable distance from its articulating fellow. The epiphyseal plates, nevertheless, should meet this basic requirement: approximating borders of a hinge joint should be parallel.

In normal legs the approximating epiphyseal plates of the femur and tibia are parallel. Also when the inner borders of the feet are parallel, the knees and ankles both should touch, as they do in Figure 3. This figure likewise illustrates the method of standing to determine the degree of deformity, which can be measured in centimeters between either the knees or the ankles, according to which type of deformity exists.



A FIG. 2 B

Roentgenograms of right legs and feet of dogs shown in Fig. 1. A. — Normal dog: epiphyses well calcified; close knit joints, bone ends fitting squarely even in the feet. B. — Rachitic dog: poor calcification, angular joint lines, loose fitting joints especially noticeable in the foot.

FIG. 3

Photograph of normal legs showing the easy contact of the internal tuberosities and malleoli when the inner borders of the feet are parallel and touching. (Case No. 2419.)

In rachitic knees anteroposterior roentgenograms may show one or more defects: osteoid tissue and perhaps osteoporosis, cupping or feathering at the epiphysis, thinning of the cortex of the shaft, disappearance of the cortex too far from the epiphyseal line, transverse lines of deposited calcium in the diaphysis at various distances from the epiphyseal plane, and an epiphyseal plate not at right angles to the long axis of the bone shaft. A typical example of this last defect in a child with florid rickets is shown in Figure 4. It is noticeable that the epiphyseal lines of each knee if extended would meet at an acute angle. With the femur and tibia coming together on the outside, knock-knees would, of couse, result: the fascia and tendons on the lateral side of the knee would in time become shortened, while those on the medial side would be lengthened. The vacant space between the epiphyses in the open part of the angle gradually fills up with calcified bone, and new epiphyseal planes are formed, parallel to each other but at an abnormal angle to the long axis of the diaphyses of both the tibia and the femur. Until such a joint becomes fixed in a normal or a valgum or varum position, a decided lateral mobility is demonstrable. This exaggerated knee mobility is often the first sign of leg rickets.[2] A normal knee gives a lateral movement of three centimeters or less, as measured at the heel, regardless of the length of the leg. To follow the progress of a case of rachitic loose-jointedness with the x-ray is too expensive for the average family. A knee mobility arthrometer was devised so that mathematically accurate monthly records could be obtained (Fig. 5). In other words the arthrometer readings are an accurate index of the amount of "wabbliness" at the knee. As the condition improves by the deposition of calcium at the epiphyses, the amount of lateral motion at the knee becomes less.

The initial advantage of knee mobility measurements is in demonstrating quickly by a simple mechanical device without resort to the x-ray or other laboratory tests, whether or not genu valgum or varum is imminent. After such a deformity has developed, its value lies in determining whether the joint has become so set as to require braces for correction. Such a case is illustrated in Figure 6. The mobility measurements were normal. It is noticeable that the bones at the knee are well calcified and the epiphyseal lines parallel. The joints were fixed in this abnormal position. This case was sent to an orthopaedic surgeon, who kept

the boy's legs in braces for two years or until the deformity was completely corrected. His photograph (Fig. 7) is interesting as showing the great distance (8.5 cm.) between the internal malleoli, when the distance from knee joint to sole was only twenty-two centimeters.

The ankle and foot being much more complicated in structure and function than the knee, rickets of the foot is more difficult to measure by mechanical means. It is impossible to include in a single roentgenogram all the tarsal articulations. One can obtain a parallel alignment of the articulating surfaces of the tibia and astragalus by placing the feet above the plate as follows: let the heels rest several inches apart on the plate, the great toes are then approximated, thus causing the medial borders of the feet to form an angle of seventy-five to one hundred degrees. We are indebted to Dr. William Dixon of our city for a device which greatly aids in a proper alignment of the feet for comparative study.

The clinical determination of flat-foot by use of the foot-print, valuable as it is, is often misleading. The important question in diagnosis is: does the arch roll downward and inward when weight is placed on the foot? Perhaps the simplest method of testing this is to have the child stand "on the toes" and then settle slowly backward onto the heels. If the tuberosity of the scaphoid is neither visible nor palpable when the weight is on the transverse arch of the foot but becomes prominent when the weight is on the longitudinal arch, functional flat-foot is present. The amount of rotation may be recorded by the use of one to four plus marks.

FIG. 4

Roentgenogram of rachitic legs in a child twenty-two months old. The epiphyseal lines of each knee if extended would meet at an acute angle. The child's weight impels the lateral borders of the knees to impinge, thus causing a knock-kneed posture. (Case No. 1515.)

COMMENT

The detection and study of rickets of the lower extremities should lead to remedial measures. It is commonly stated that children outgrow early rickets. Yet among the first 1,000,000 men to be mobilized during the Great War one rachitic deformity, flat-foot, was found to be practically as frequent (177 per 1000) as all other diseases and deformities combined (180 per 1000).[3] More recent statistics show that rachitic abnormalities are by no means uncommon in adults as shown by Harvard's report[4] after the examination of several thousand students, and by the report of Dr. Walter Anderson[5] of the Portland Naval Recruiting Station. During the past three years 6375 young men were examined here for the Navy and Marine Corps, forty per cent. of whom were rejected for physical unfitness. Our examination of school children shows that less than ten per cent. can be given a posture grade of "A" and still fewer receive a weight-bearing grade of "A" (entire absence of flat-foot).

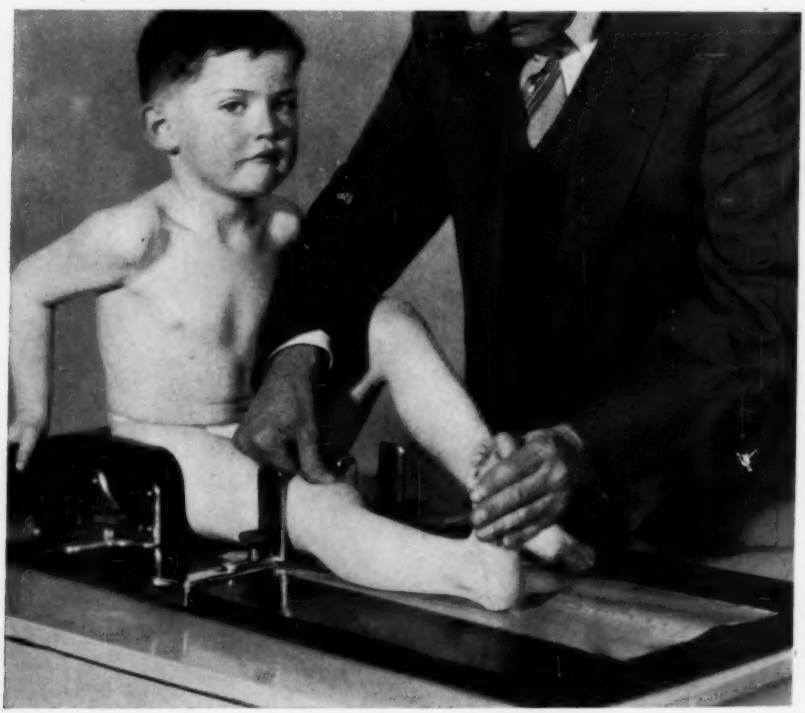


FIG. 5

Knee mobility arthrometer in use. Adjustable uprights at the pelvis and the lower femur secure immobility of these points. If the knee be pressed down firmly and the foot held erect to tighten anterior and posterior ligaments rotation at the knee is prevented. In this position any sidewise movement at the heel gives an accurate measurement of the lateral mobility at the knee. (Apparatus made by Peninsula Pattern Works, Portland, Ore.)

Etiological studies have definitely shown that rickets has at least three contributory causes:

(1) Inheritance extending back three generations.
(2) Improper nutrition extending back to the youth of the mother.
(3) Lack of heliotherapy or proper skin hygiene.

In animal experiments it often requires three generations to produce rickets by diet in a strain of animals formerly free from the disease.[6] On the other hand, when once the defect is established, the offspring very readily exhibit the results of a rickets-producing diet, and, in fact, show a tendency to recurrence even when the diet is considered adequate.[7] In clinical practice one frequently finds signs of rickets in the children of rachitic parents, even when the utmost dietetic care has been exercised, almost from the time of conception, to prevent its development.

Elimination of rickets must begin with the infant if not with the parent. The presence of craniotabes or costomalacia[2] during infancy is prophetic of rickets of the legs and feet later on, thus indicating a need of antirachitic treatment at once. Breast milk is essential because breast-fed babies are less frequently and less severely affected and more easily cured. Cod liver oil should be begun in ten-drop doses at ten days of age, increasing to one teaspoonful or more daily when three months old. After weaning, a well balanced diet with a sufficiency of butter-fat[8] and leafy vegetables is necessarily an important adjunct in preventing or curing rickets. Fish livers, as

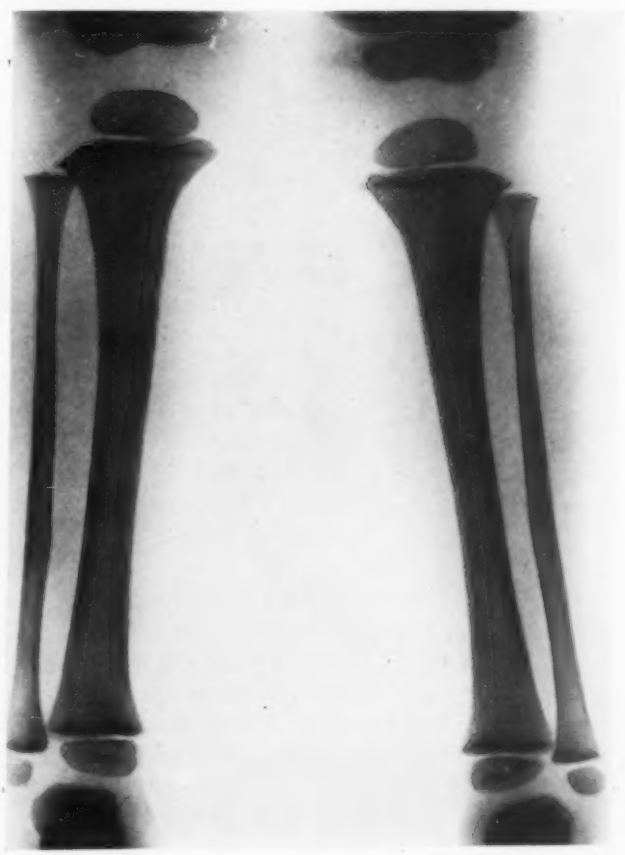


FIG. 6

Roentgenogram (taken standing) of a case (No. 2130) of genu valgum with epiphyses parallel and so well calcified that lateral mobility is within the three-centimeter limit. Hence correction required braces.

FIG. 7

Photograph of case No. 2130 showing the great distance between the internal malleoli when the internal tuberosities of the femur are approximated. It is also noticeable that the scaphoid bone has rotated inward and the arch flattened.

from salmon, and other sea foods containing the anti-rachitic vitamin D should routinely be in the diet of school children.

Heliotherapy is an extremely important preventive and curative measure. It should be instituted at one month of age by exposing the baby's arms and legs to the sunshine or at least to the air for a certain period each day. Anything that causes perspiration with its attendant loss of minerals should be avoided.

Infants and children had better be underclothed than overclothed, although neither is necessary. Blueness of extremities indicates a need of more clothing or a warmer atmosphere; sweating shows that the optimum amount has been exceeded. Between these lies the field of proper clothing. Two thicknesses of cloth is often too much, as illustrated by the following incident. Two children from the same family appeared in April for their semi-annual examination. The four-year-old showed a knee mobility of five centimeters, while the twenty-months-old registered a knee mobility of only one and five-tenths centimeters. This, too, in spite of the fact that knee mobility is most pronounced from eighteen to twenty-four months of age. This child had the lowest reading found by us since the previous summer. The mother said the children had similar diets, including cod liver oil, and the same surroundings. The only difference was in the amount of clothing. While the boy had worn only B. V. D's and overalls, his little sister had gone nude all winter except when away from home. Their home too had the variable heat furnished by stoves.

The scientific demand for less clothing as an aid in preventing rickets and improving health is shown by the popularity of bathing suits for play suits. Recently a progressive swimming suit manufacturer, (the Jantzen Company), recognizing the increasing interest in heliotherapy, has produced a "sun-suit" which exposes a greater amount of skin surface to the sun. Children prefer it to the heavier, older type of suits.

## SUMMARY

Our study demonstrates that the relation of rickets to genu valgum and static flat-foot is direct.

Signs of rickets in the bones of the head or chest at any time during the first year of life indicate that rickets of the legs and feet will probably appear during the second year and possibly again at puberty.

Roentgenograms of the legs of young animals and of children show that in early rickets the weight of the body causes the joint lines at the knee to form an acute angle instead of being parallel.

The amount of lateral mobility at the knee is an accurate index of the degree of leg rickets in the early stages and later demonstrates the progress being made toward a cure. The knee mobility arthrometer has proved a valuable and inexpensive means of taking such measurements rapidly.

These studies indicate that static flat-foot is a form of rickets. During rapidly growing periods the ends of the metatarsal bones are so soft that the formation and maintenance of a normal arch is impossible.

The presence of static flat-foot is easily determined clinically by noting the amount of inward rotation of the scaphoid bone when the patient stands "on his toes" and settles slowly back onto his heels.

Mechanical devices are helpful in curing rachitic deformities of the legs and feet which have become fixed, but do not prevent a return of the condition unless anti-rachitic therapy is administered concurrently.

Our aim in the treatment of rickets should be not only to improve the existing dyscrasia, but also to prevent its recurrence in the offspring.

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# END RESULTS AND THE FOLLOW-UP IN ORTHOPAEDIC SURGERY*

BY WM. A. ROGERS, M.D., BOSTON

During the past year an end-result clinic has been conducted by the Orthopaedic Service of the Massachusetts General Hospital. The plan of its organization is as follows: One Sunday morning in each month is designated as the time to report for all cases operated upon during that month of the preceding years. Thus the Sunday designated for January 1926 was made the day to report for all cases operated upon during January 1924 and January 1925. (Such monthly clinics, in the case of a service doing about three hundred and fifty operations a year, will average between thirty and forty patients at a clinic.) A card prepared for the purpose is sent to every person the date of whose operation fell within the month, inviting the patient to the hospital at this time for examination. With this invitation a return post card is enclosed upon which the patient marks whether or not he or she will report, and mails it back.† The envelope containing these two cards is labeled with the hospital address so that in case the patient has moved without leaving a forwarding address the letter will be returned and the patient listed as lost or to be further searched for. The letters are sent ten days prior to the clinic, and the staff notified. Case records and x-rays are made available for each clinic.

The results obtained by this organization are as follows: Seventy-five per cent. of the cases sent for reported, and records were made of the findings. Thus, out of 532 cases operated upon almost 400 were examined by the staff as a whole and the findings dictated and recorded. The records now include, in addition to the pre-operative findings and description of the treatment, the condition of the patient one and two years after operation. It is the plan to continue this policy with certain types of cases up to five or more years, and certain others, as those of proven tuberculosis, indefinitely.

The following is an analysis of the response:

TABLE 1.

| | | |
|---|---|---|
| Cases reporting after one notification. | 220 | 41% |
| Cases reporting after two or three notifications. | 70 | 13% |
| Cases reporting to Out Patient Department at time of end-result clinic, or followed in other institutions, or by some member of the staff. | 80 | 15% |
| Cases reporting voluntarily by letter, unable to come due to distance or finances. | 20 | 4% |
| Deaths | 10 | 2% |
| Total | 400 | 75% |

*Read before The Boston Orthopaedic Club, April 1927.

†Over ninety-eight per cent. of the cases who reported took the trouble to mail back the return post card in time for the clinic.

Analysis of cases not reporting:

TABLE 2.

| | | |
|---|---|---|
| Cases whose letters were returned "moved, no address". | 38 | 7% |
| Cases who did not answer. | 74 | 14% |
| Cases who had moved away over 100 miles | 7 | 1% |
| Cases who accepted but failed to report | 8 | 2% |
| Cases who answered "can not" or "decline to come". | 5 | 1% |
| Total | 132 | 25% |

Analysis of the seventy-four cases who did not answer, the largest group which we failed to get back:

TABLE 3.

| | |
|---|---|
| Failed to report for follow-up care. | 25% of this group |
| Gave up treatment before maximum benefit was reached. | 35% " " " |
| Follow-up phase completed. Discharged. | 33% " " " |
| Transferred to other hospital or service. | 7% " " " |

The actual cost to the Service in securing this return of operated cases for review amounts to $46.00, chiefly for stamps and stationery; the staff hours of actual labor of preparation about twenty-eight, spread over one year.

Let us compile a table representing an estimate of the yearly totals of the more common conditions treated by nineteen of the well known Orthopaedic Services in America which are closely affiliated with A-plus Medical Schools. The figures may be computed on the basis of the percentage for each condition in the two-year run of material at the Massachusetts General Hospital. Let us assume that the yearly total of cases treated by these nineteen services is 5000. Then, assuming that seventy-five per cent. of all cases report for end-result study, we can compute the series of cases for each condition available for clinical analysis:

TABLE 4.

| *Operation for** | *M.G.H. Per cent.* | *Total for 19 Services* | *Series available for study* |
|---|---|---|---|
| Infantile paralysis | 17 | 850 | 640 |
| Internal derangement knee | 5 | 250 | 188 |
| Arthroplasty great toe joint | 5 | 250 | 188 |
| Tuberculosis of joints | 22 | 1100 | 825 |
| Chronic osteomyelitis | 3 | 150 | 112 |
| Gonorrheal joint | 2 | 100 | 75 |
| Torticollis | 2 | 100 | 75 |
| Chronic toxic arthritis | 3 | 140 | 105 |
| Acute septic joint | 2 | 125 | 94 |
| Sacro-iliac joint condition | 4 | 200 | 150 |
| Arthroplasty of hip | 5 | 250 | 188 |
| Rachitic deformities | 4 | 200 | 150 |

In the above table no allowance has been made for the variation in frequency of the different conditions throughout the country.

*Orthopaedic procedure as open operation, manipulation under anaesthetic, etc.

## THE FOLLOW-UP

The follow-up of a patient who has undergone hospitalization applies to the phase of treatment between the time of discharge from the hospital and the time when the patient has reached the maximum lasting benefit or the end result.

It has long been an axiom among social workers that in a large group of cases the degree of success of the contact—patient, social service, surgeon—determines to a marked degree the quality of work done. Furthermore, this contact reacts directly upon the proportion of cases taking the trouble to return for end-result study.

During the past year the follow-up work has been reorganized on this Service and the results obtained have encouraged the Service to continue along the lines established. Its organization is as follows: The responsibility for the follow-up has been placed directly with the operating surgeon who, it would seem, is the most logical one to assume it. In him the patient instinctively has confidence. He, above the others of the surgical staff, is the one most directly interested, certainly most involved.

The patient is followed by him personally in the Out Patient Department, by appointment. He personally treats the patient, or directs the treatment, employing the usual outpatient agencies as he sees fit, always holding himself responsible for the outcome and always aiming to hold the contact. Under such a regime it is but natural that a sense of responsibility is aroused in the patient, and we find that we are dealing with an enthusiastic, cooperative person rather than a passive, bewildered one.

The social service staff is indispensable, being a connecting link between the two parties, surgeon and patient. This triple contact—surgeon, social service, patient—is first established in the hospital during the patient's stay there. At the time of the patient's discharge from the hospital the surgeon designates on a special card, the social service or after-care card, when the patient is first to return to the Out Patient Department, and outlines the plan of treatment. A card is also given the patient with the date of first return visit marked.

The arrangements for after-care are then explained to the patient, the general plan outlined, and the importance of cooperation emphasized.

At each visit the surgeon designates on the cards the time of the next visit, and the social service keeps informed of each phase of the treatment by the after-care or social service card, so as to facilitate and check up the patient's progress. Social service notifies the surgeon by post card just prior to his next appointment.

The following table represents a brief summary of the status of this work:

TABLE 5.

*January 1, 1926 to January 1, 1927*

Total Operated Cases—384

| | | |
|---|---|---|
| Cases followed through to end-result phase. | 81 | or 21% |
| Cases followed and being followed by operator but not listed as end result. | 233 | " 61% |
| Cases transferred to L.M.D. or to other institutions. | 47 | " 12% |
| Cases who never reported for follow-up care. | 3 | " 1% |
| Cases lost track of. | 20 | " 5% |
| Total | 384 | 100% |

This organization, in operation for the past fourteen months, has, we believe, eliminated many of the faults to be found in an unorganized or purely mechanical outpatient follow-up of cases. The patients receive far better care, are far more cooperative and, we hope, will return in greater proportion for end-result survey.

The author wishes to express his thanks to Dr. John A. Hartwell of New York City for many ideas and practical experience in end result work in the past.

# FRACTURE OF TARSAL SCAPHOID

## With Notes on the Mechanism

BY EDWIN P. LEHMAN, M.D., AND I. H. ESKELES, M.D., ST. LOUIS, MO.

*From the Department of Surgery, Washington University School of Medicine*

Fractures of the tarsal scaphoid are not exceptionally rare. Hoffmann's review of the subject in 1908[1] records twenty-five cases. Modern text-books on fracture dismiss the subject with brief comment and without presenting a clear-cut conception of the mechanism. A study of the mechanics of the tarsus in connection with a recent clinical experience furnished the material for this presentation.

### CASE REPORT

A. L., workman, of thirty-five years, fell from a roof two and one-half stories high, landing on his feet upon ground covered with broken brick. He suffered a comminuted fracture of the tarsal scaphoid of the left foot, a transverse fracture of the fourth metatarsal of the right foot near the lower head, and a traumatic synovitis of the left knee. The last two injuries were not unusual and need no further comment.

The fracture of the tarsal scaphoid could be readily diagnosed clinically, inasmuch as fragments of the bone were displaced upward and could be felt and moved about subcutaneously. There was shortening of the mesial border of the foot. The roentgenograms (Figs. 1 and 2) showed marked comminution of the bone with at least two major fragments. One of them was displaced upward carrying the proximal joint surface with it and could be felt under the skin, the other was displaced mesially and included the tubercle.

Under gas anaesthesia an attempt was made to reduce the fracture. Traction and

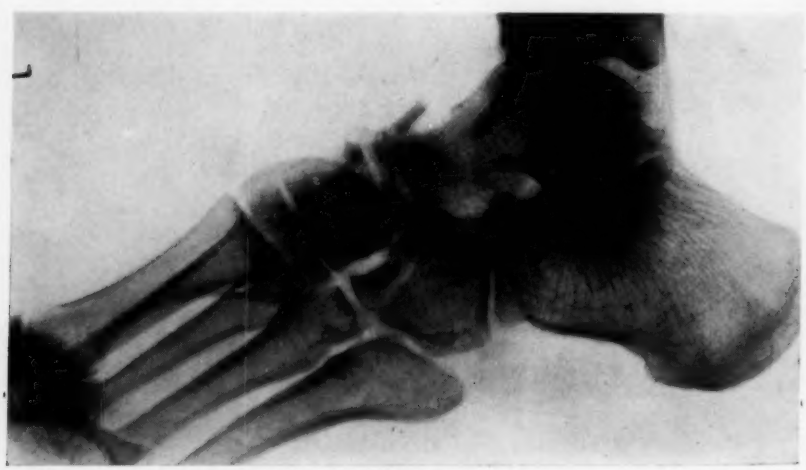

Fig. 1

Fracture of tarsal scaphoid.

FIG. 2

Fracture of tarsal scaphoid. Note shortening of mesial border of foot.

abduction of the metatarsus was employed to widen the space in which the normal bone should be. Manipulation of the fragments then effected a satisfactory reduction, which, however, could not be completely maintained. Apparently the synovial surface of the upper fragment rode so smoothly on that of the head of the astragalus that the slightest force would displace it. However, by keeping pressure on this fragment and by maintaining traction and abduction during the application of a plaster cast, a partial reduction was obtained.

The cast was retained for six weeks. At this time roentgenograms (Figs. 3 and 4) showed marked improvement over the original condition. There is still moderate narrowing of the scaphoid space and a portion of the original bone above and mesial to the normal outline. There is no evidence whatever of bone absorption. The fragments have apparently united.

FIG. 3

Fracture of tarsal scaphoid; end of six weeks. Note partial reduction with union of fragments and no absorption.

FIG. 4
Fracture of tarsal scaphoid; end of six weeks.

The patient was given a fitted steel arch support which he wore for four weeks. He discarded it spontaneously and has been able to go back to work with a symptomless foot. The displaced fragment on the dorsum of the foot can be felt, but gives the patient no discomfort from shoe pressure. After-treatment included baking, massage and active movements from the time of removal of the cast.

In discussing the mechanism of this fracture, the usual distinction between fractures caused by direct and those caused by indirect violence must be preserved. The former need not concern us at present.

In fractures of the tarsal scaphoid by indirect violence, the two factors most frequently met are (1) a fall on the foot from a height, and (2) the presence of plantar flexion at the moment of impact. The fracture is usually described as a compression fracture by force transmitted downward through the head of the astragalus and the cuneiforms. Finsterer[2] in an excellent résumé defines the various lines of force through the tarsus that may with varying positions of the foot result in different types of scaphoid fracture. He mentions the tearing of the dorsal ligaments from plantar flexion and its relation to dislocation at the astragalar head. If the tear is only partial, then, he says, "The head of the astragalus comes in contact with the plantar portion of the scaphoid and fractures it". Stimson[3] says, "The mechanism is apparently compression between the head of the astragalus and the cuneiform, possibly with forced flexion of the mediotarsal joint".

In approaching these conceptions critically one is struck in the first place by the close support given to the scaphoid by its neighboring bones. It is hard to conceive of a fracture of the scaphoid occurring with intact ligaments. One would expect the metatarsal bones to give way first, inasmuch as the force applied through the scaphoid is distributed over its entire surface by the closely molded joint surfaces of astragalus and cuneiforms. Possibly this explains the relative rarity of fracture of this bone.

On the other hand, once postulating a tear of the dorsal ligaments,

such as a history of plantar flexion makes possible, there is at once a concentration of force over a small area of the bone. Fracture under these circumstances becomes easy. It is this factor that Finsterer recognizes in the sentence quoted. However, one can question whether his application of the principle is the only application.

A study of the ligaments connecting the astragalus with the scaphoid and the scaphoid with the cuneiforms shows the former to be the stronger. They are reenforced by prolongations of the mesial and lateral ligaments of the ankle joint. An experiment was performed on a fresh cadaver to determine which would be the first to give way under sudden forced flexion of the foot, such as would occur if the foot were bent over an object in the instep (such as a fragment of broken brick), as the body struck the ground. In this experiment no fracture occurred and, from difficulty in controlling the tarsus, the ligamentous tear occurred in the anterior tibioastragalar region. However, an opportunity was afforded of comparing the dorsal astragaloscaphoid with the dorsal scaphoidocuneiform ligaments in the fresh state. It was confirmed that the former are about three times as thick as the latter.

The determination of the relative strength of the two sets of ligaments becomes important when one considers the results of extreme flexion of the foot at the two joints. If one takes the articulated skeleton of a foot, and, seizing the astragalus and os calcis in the one hand, the metatarsals and cuneiforms in the other, sharply flexes the foot, the gap first appears between the upper borders of the cuneiforms and the scaphoid. Later the upper borders of astragalus and scaphoid separate. This observation shows that the mechanical relationship of the bones has a tendency to throw the first strain on the weaker ligament.

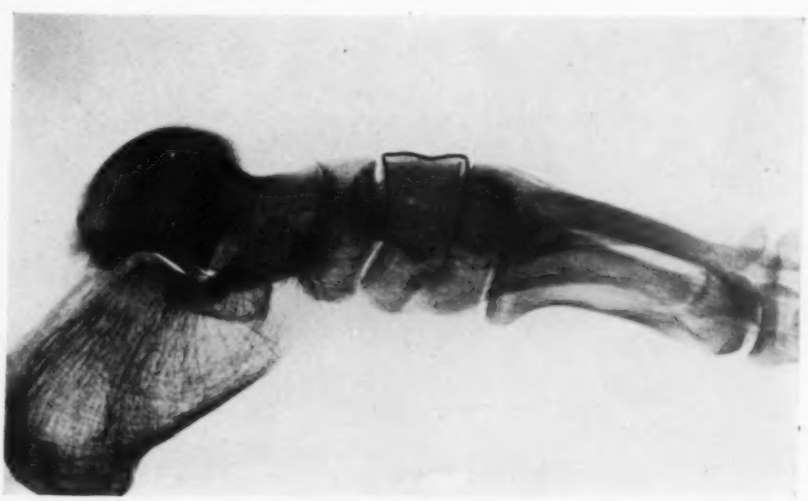

FIG. 5

Articulated skeleton of foot in normal relationship. The outline of the middle cuneiform has been sketched in.

If one grasps the scaphoid and astragalus and deliberately limits the separation to the proximal tarsal joint in order to fulfil Finsterer's conception, one finds that the lower border of the head of the astragalus lies in contact with the sharp lower border of the convex upper articular surface of the scaphoid over a distance of about one centimeter. Application of the body weight to the scaphoid over this linear distribution might fracture the bone. This is Finsterer's idea of the mechanism.

However, if one examines the relations that the bones assume to each other in forced flexion at the medial tarsal joint—where we have seen that the ligamentous tear should first occur—one finds conditions more favorable for comminution of the scaphoid. With the articulated foot flexed, either at the joint between the cuneiforms and the scaphoid alone, or at both joints, the sharp inferior proximal angle of the middle cuneiform rides slightly up over the distal joint surface of the scaphoid and lies as a single point near the middle of the bone. It is easy to see how the body weight transmitted by the astragalus through the scaphoid and resisted by this single point of impact, could drive the latter into the scaphoid and shatter the bone. The relations are clearly seen in the roentgenograms of the skeleton of a foot taken in normal relationship (Fig. 5) and in flexion at the medial tarsal joint (Fig. 6). The outlines of the middle cuneiform have been drawn in from caliper measurements of the actual bone to show the position it assumes.

It is probable that Stimson's description quoted above is intended to include this conception. However, it is important to stress the tear of the dorsal ligaments either proximal or distal to the bone, without which fracture seems hardly possible.

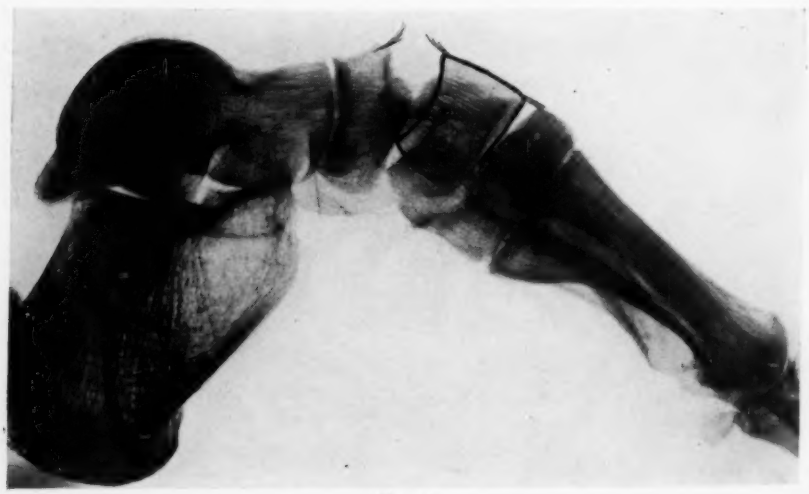

FIG. 6

Articulated skeleton of foot sharply flexed at medial tarsal joint. The sketched outline of the middle cuneiform shows its relationship under these circumstances. The tear of the ligaments is indicated.

The demonstration of a possible mechanism of fracture by flexion at the medial tarsal joint is not intended to imply that it is the only mechanism. Strains may be applied to the mid-tarsus in many different directions, and consequently the resulting ligamentous tear may be in any portion of the strong fascial support that anchors the scaphoid to its neighbors. Such a tear will at once localize a compressing force at a small area on the bone, and fracture will result. It is suggested that a tear of the scaphoidocuneiform ligament is presumptively the first to occur in forced flexion of the tarsus and that when it has occurred the positions of the bones are such as to make fracture possible.

## SUMMARY

(1) A case is presented of fracture of the tarsal scaphoid from indirect violence with excellent functional result.

(2) A study of the tarsus suggests that fracture of the scaphoid from indirect violence is not probable without ligamentous tear.

(3) A possible mechanism of fracture is presented as follows: (a) Forced flexion of the foot with resulting tear of the dorsal scaphoidocuneiform ligament. (b) Transmission of force in the axis of the foot driving the scaphoid against the upturned sharp inferior proximal angle of the middle cuneiform.

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# CONTINUOUS TRACTION IN THE TREATMENT OF SPINAL CONDITIONS, NOTABLY SCOLIOSIS*

BY CHARLES LE ROY LOWMAN, M.D., F.A.C.S., LOS ANGELES, CALIF.

After five years of trial, we feel justified in speaking with some degree of satisfaction of our method of handling the ever present and discouraging entity, scoliosis. The satisfaction is not, however, with the degree of correction obtained, as much as with the fact that we can handle certain types of cases with better results than by any method which we have heretofore tried.

The general course of treatment has developed into a sequential use of recumbency, traction, casts, braces, exercises and operations in accordance with severity, cause, and position of the curves and the constitutional condition of the patient.

These different methods must be adapted to the varying needs of the patient as well as to the spinal condition and changed to suit these needs: for instance, going from traction to brace and exercises without casts, or from braces back into casts or traction, as seems best under the existing circumstances involved.

We began the use of continuous traction some years ago with some back cases of scoliosis of paralytic type in some frail puny children with marked chest distortions, crowded hearts, and insufficient lung ventilation. The use of plaster or braces obviously offered little, if any, hope of doing anything but make them weaker. Because of the satisfactory use of continuous spinal traction in such cases as Pott's disease, spinal fracture, and lumbar root irritation, we began to try it out on these frail children.

A carefully made head halter or sling was applied with the patient recumbent and the head of the bed raised at first four inches, then increasing in a few weeks, two inches at a time, until eight or ten inches in height had been reached. Longitudinal, spinal, and chest tracings, also lateral tracings of trunk over the back and chest at definite curves, were taken before beginning treatment. In cases of home treatment, mothers were instructed to give certain manual corrective movements, such as pressure on the convexities with patient extending the arm upward on the side of the concavity and breathing exercises to force out flattened and hollowed areas of the thoracic cage, passive stretching movements to open up the curves, and manual traction on the legs while the patient grasps the head of the bed with the arm of the concave dorsal side, constantly pulling hard on the leg of the concave side.

Special attention was given to the body by giving alcohol rubs to

*Read before the meeting of the American Orthopaedic Association, Yosemite Valley, California, June 1927.

prevent bed sores, and tonic rubs over weakened muscles of convexities. Particular attention to medication for improving alkaline metabolism, and tonics for building up vascular tone and combatting anaemias were also given. Elimination of the cause received special attention along with dietetic consideration, the latter aimed especially to combat tendencies toward acidosis, which accompanied most of these cases.

These home-care cases were returned to the clinic every four to six weeks, being transported in recumbency and were remeasured and inspected. Greatly to our satisfaction, we noted improved color, happier dispositions, lessened lines of fatigue on faces previously drawn and pinched, increased chest capacity, lessening of the concavities, considerable acuity taken from the previously sharp convexities, gain in weight, and raised hemoglobin. The mothers were pleased that something was really being done for the children, some of whom had been made worse by improper treatment to which they had been subjected.

We no longer pronounced these cases hopeless, or used dubious and difficult means of correction which the poor condition of health rendered questionable. Instead, we used this method, which in a heavy clinical practice made it possible to do something constructive honestly, and to encourage cooperation in the parents, which resulted in sufficient general improvement to warrant further advances in treatment, such as casts or braces, in a few months, with no objection on the part of the parents when fusion operations were resorted to for final control.

Upon the opening of our own hospital, we were enabled to go into the matter more deeply. The use of the Hibbs traction frame for stretching postoperative fusion cases for the application of jackets, suggested to us the use of the traction girdle in connection with our head traction halter for continuous use. This succeeded so well that we applied the method to many of our scoliotics and other back cases, as a preliminary step in their treatment, using five pounds on the head and ten pounds on the pelvic pull at the start, gradually increasing to as much as fifteen pounds on the head and twenty-five pounds on the counterpull in some instances.

The same careful attention to the patient's general condition (particularly the lungs) was given as stated above, only in a more precise fashion and with more accurate physiotherapy applied by trained technicians.

We next turned our attention to the rotation deviations, and, having used in the gymnasium years ago a modified Lange's crib, and, of course, having the same principle in our Abbott frame and also on the Hibbs frame, we placed the Hibbs frame on the bed and used its windlasses for applying anterolateral pulls. This showed us that lateral traction continuously applied was an important step in advance, but could not be properly applied by means of a fixed windlass, because movement of the patient disturbed the pulls and rendered them inaccurate or harmful. Furthermore, for young adults, the Hibbs apparatus was too short, and its framework, resting on top of the bed, was in the way. The next step was the devising of a gas pipe frame attached to the head and foot of the bed, with projections

of two feet beyond both head and foot, to which traction pulley could be attached at such an angle as to be in proper line of pull. To overcome the difficulties involved in keeping the lateral pulls constant and in position, we placed large spools on the side rods over which played the cords carrying the weights attached to the lateral pulley bands.

In cases with much lateral flattening of the thorax and in order to prevent this from increasing, as well as to give a forward oblique lift to better control the rotation, a rod directly above the patient to the right or left, carrying spools, was also used, the band passing up and over this suspended spool on the side rod from which drops the weight.

These lateral bands are of canvas (reenforced with stays) over the area which comes in contact with the skin, and are of varying widths in accordance with the needs. No stiffening should be placed in the bed as the springs and mattress should sag, in order that the spinal flexion occurring thereby may render the column more mobile, and also so that the weight of the body may hang more heavily in the latero-rotary bands.

If for any reason the head sling is contraindicated, good results may come from using the pelvic pull and raising the foot of the bed for counter-traction. As a precaution, the pelvic pull often has to be discontinued or lessened during the menses.

One of the most valuable corrective factors in this combination of longitudinal and lateral traction is the improved influence exerted in high dorsal curves. It is axiomatic in deformity correction that there should be points of pressure and counterpressure, and these points are at the apex and the ends of the curve to be corrected. When the end of a dorsal curve is higher than the axilla, there is no place to put an upper counterpull or thrust, except against the shoulder or neck, which in either instance is impossible or dangerous. This point is frequently lost sight of by surgeons putting these patients in jackets, corsets, or braces, that stop in the axilla on the concave side, and consequently the top becomes a point of pressure in concavity and not at its end, hence often increasing the deformity or actually preventing the rib excursion in the concavity when it is so greatly needed.

The head traction pull, transmitted through the cervical ligaments, becomes the only possible counterforce which makes the dorsal pull effective or prevents a transposition into a compensating cervical curve. When first applied, care should be taken to see that the head halter is adjusted so that the maximum pull comes on the occiput and not so much on the chin, and also that the chin pull is directly upward against jaws and not backward on the front of the chin. The child's mouth should be inspected weekly to see that malocclusion of teeth does not occur.

At first only two or three pounds should be applied from fifteen to thirty minutes, with a similar time off, the weight being increased as fast as the patient can stand it.

Before using traction, all cases should have a careful lung examination clinically and by x-ray, when possible by a specialist. In all cases of

FIG. 1

J.F.—Tracing from x-ray, April 13, 1926. After osteopathic treatment.

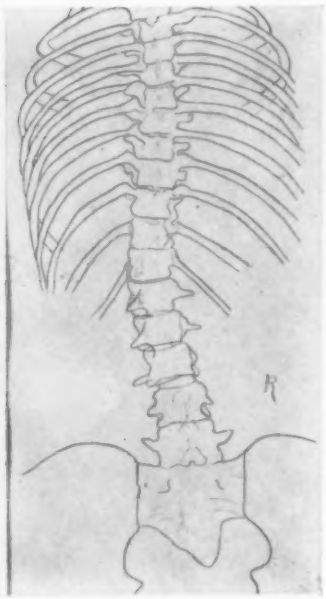

FIG. 2

J.F.—Tracing from x-ray, May 17, 1926. After one month of traction.

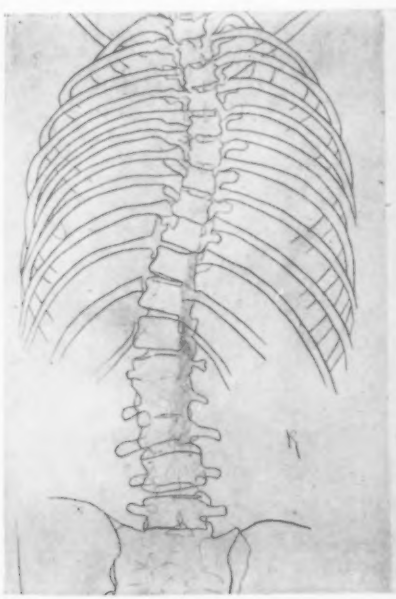

FIG. 3

J.F.—Tracing from x-ray taken eleven months after operation.

FIG. 4

J.F.—Showing spine July 28, 1927, one year after spinal fusion.

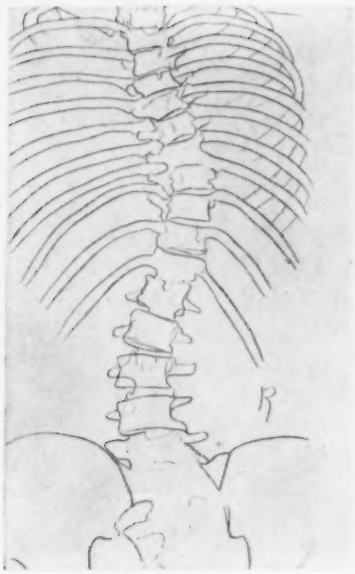


FIG. 5

T. S.—Tracing from x-ray August 4, 1925.

FIG. 6

T. S.—Tracing from x-ray May 18, 1927, eleven months after operation. Moderate increase of deformity in spite of treatment previous to operation.

incipient lung involvement, and also in suspicious cases, the foot of the bed should be raised and the pelvic traction applied first, allowing the body to exert its own countertraction; then in a week head traction may be applied continuously, the lung condition, temperature, etc., being watched carefully.

One of the most important points demonstrated is an enormous saving in time and expense to both patient and hospital, because of the decreased number of casts necessary. We are all familiar with the fact that in cases treated by casts, changed every four to eight weeks, the greatest corrections are made in the first three or four casts, or in the first six months of treatment. We influence chiefly muscles and ligaments, and the more movable spinal segments during the early stage, whereas the rigid areas of the deformity become our problem later on.

Continuous traction for four to eight weeks will accomplish as much usually as the first six months of cast treatment, to say nothing of its obvious advantages already cited, from rest, recumbency and improved hygiene.

Another factor of value to the surgeon whose clinic may be heavy and whose in-patient service may be limited as to funds and beds, or in cases in which family conditions make it impossible to have hospital care, is that, at least as far as the longitudinal traction is concerned, it can be applied for a few days at the hospital and the patient can then be sent home, having the bed at home adjusted by a technician, and can begin the first

four or eight weeks of treatment at home. Then he may return to the hospital for a few days or weeks of more intensive treatment, when lateral correction can be applied and x-ray studies made before the first jacket is put on. Bed exercises can then be started.

The patient is taught to lie with the arm on the side of the thoracic concavity up and the opposite arm down, especially while attempts are made to localize breathing and muscle action in the effort to blow out the concavity. This power of localization in some instances can be remarkably developed.

It is of utmost importance to have x-ray studies and also photographic records when possible. Roentgenograms should be taken both in standing and lying positions before treatment, and then later with the traction pulls in position, in order that comparison can be made and conclusions as to further treatment arrived at. The facilities at hospitals where beds may be rolled to x-ray laboratory or portable apparatus wheeled to the ward, are, of course, of the greatest assistance in carrying out the line of treatment consistently and intelligently.

As to the value of this treatment in other conditions, we have made it practically the treatment of choice orthopaedically in all acute and painful spinal lesions such as arthritis, either infectious or tubercular, radiculitis and low back neuritis, where there appears to be root irritation or pressure, and fractures.

In the chronic cases it is especially useful in spondylolisthetic spines, lordosis, anterior poliomyelitis cases where there are hip contractures (in such cases the pulling straps are set far back on the pelvic girdle in order to pull down the buttock and sacrum), and old round backs, flexible or rigid, either arthritic or not. With ten or twelve weeks of treatment we have succeeded in flattening some old poker backs of four or five years'

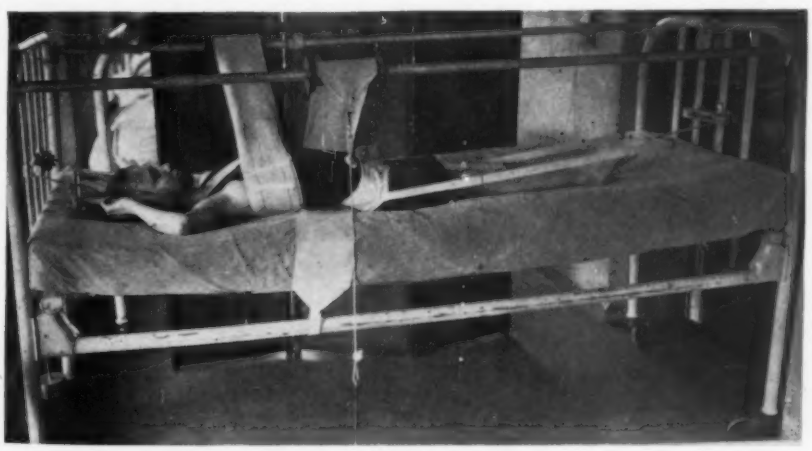

FIG. 7

Side view of traction apparatus. Note wide spools and reenforced canvas bands to prevent wrinkling.

FIG. 8

Front view from above, showing traction bands for lateral rotary and longitudinal pull.

standing, with curves which raised the head ten inches from the table in recumbency. We have also used it in all Pott's cases with paraplegia developed or incipient. For years we have used this method in low back conditions with accompanying neuritis or leg symptoms, atrophy, weakness, "sciatica", when sacro-iliac joints were not involved, and which failed to respond to conservative treatment. It also is useful in fifth lumbar impingements, compression fractures, or slippage such as occurs in the faulty inter-articular joints.

In all cases its great values lie in the fact that recumbency, rest, both local and general improved circulation, decreased reflex irritation (after the first few days) and general hygienic improvement are obtained. Above all it is possible to give other forms of treatment such as exercises, massage, hydrotherapy, etc., which is rendered impossible when the body is encased in plaster.

When x-ray studies show that a maximum degree of improvement has been obtained and constitutional conditions are favorable, we do a spinal fusion, and so far, in most instances, have centered our attention primarily on the lumbodorsal junction. Originally we did a Hibbs fusion operation on these cases, but we found that in cases with a very marked rotation, the intra-articular processes and laminae were carried so far forward on the concave side that it very naturally interfered with the nicety of the technique required for a Hibbs operation. As these scoliotics are definitely contracted, the tightness and rigidity of the structures on the concave side render necessary very heavy retraction in order to get to the bottom of the wound, hence, greatly increasing the shock and prolonging the procedure. Consequently in some rather frail cases of poor surgical risk, we attempted the following modification: While one team of surgeons prepared the spinal bed, another team of surgeons took a bone graft of the required length from the shin, which was then placed in the spinal bed, as deep in the gutter as

possible, running from shoulder to shoulder of the curve, bridging the concavity as a cord does the arc. The bone chips were laid up from the laminae and interlaced, and strips on the posterior process placed likewise, giving a very large raw bone surface. Muscles were then drawn together over the graft, and a bed brace applied.

Three weeks later while the callus was still soft, longitudinal traction of mild degree was again instituted and held thus during the subsequent eight weeks.

During the past two years we have still further modified the technique in certain instances, by denuding the periosteum and musculature from only the concave side and placing the graft, doing the combination partial Hibbs with a straight strut. We have done this in the hope that denudation would release the contracted structures on the concave side and that the slacking off and toning up of structures on the convex side would reverse the process which caused the deformity.

In a paralytic case with a concavity of eight or ten inches, the paralysis may only extend part way. Non-paralyzed muscles, however, in the remaining segment would either have no influence on the total curve or be too weak to aid in stabilization. Whereas, after the grafting of this area changes it into a stiff column instead of a movable one, any active muscles attached at any level would mechanically influence it.

We prefer to select severe cases after puberty, but the early rapid transitional cases should be attacked early and should be fused when they show the first sign of relapse.

The clinical pictures two or three years, or more, after these procedures are almost without exception pronounced satisfactory by the patients, many of whom can now stand up without support, whereas they could not stand before this was done. We also find a very marked influence on their ability to walk, even in the presence of a bad paralysis of the legs, because the lateral stabilized muscles of the pelvis have a fixed foundation to work from instead of a wabbly one.

## CONCLUSION

We do not offer these suggestions as completely curative in cases of scoliosis, but feel that this method does greatly decrease the ever burdensome problem which we have all experienced. We do feel that early, rapid cases could practically be strengthened by this method when in the transitional stage and should be fused if they fail to remain straight after traction, cast, brace and exercises have been used. We feel that otherwise hopeless cases can be kept from the scrap heap and be given honest and efficient help. As a time-saver to both surgeon and patient it is a winner, and as a help in obtaining improved hygiene as well as morale, it has no equal.

## DISCUSSION

Dr. Samuel Kleinberg, New York, N. Y.: The method which Dr. Lowman described and which he told me he had been using for four or five years, has been in use at the Hospital for Ruptured and Crippled for at least eight years. The first case I

operated on was in 1919. Our system is approximately the same; in some respects it is superior to the one Dr. Lowman uses. We use a convex frame, taking our cue from the treatment of Pott's disease on the convex frame. That is superior to the flat frame because it affords opportunity for the reduction of the posterior projection of the ribs and the deformity of the back. It permits greater extension of the chest and at the same time provides all the traction we desire. Our system has been as follows: We place the child on a frame with traction for about eight weeks. As I had occasion to call attention in an article in 1922 and in another in 1923 and as Dr. Whitman set forth in an article he wrote for the *American Journal of Orthopaedic Surgery* in 1921, we believe that we can get the maximum improvement in four to eight weeks. We use anywhere from thirty to eighty pounds of traction, twenty to thirty on the head and forty to fifty on the pelvis. We use the ordinary head halter and a canvas pelvic support for traction on the lower part of the body. At the end of the period of maximum improvement, from four to eight weeks, we fuse the spine and then place the child on a frame in traction for another eight weeks, at the end of which time we think fusion is complete. We carefully guard that child against mobilization of the back. I entirely disagree with Dr. Lowman in his mobilization exercises after fusion. We know that by mobilization of the back we lay the child open to further deformity.

We have up to date operated on 150 cases at the hospital. I have personally operated on eighty and Dr. Armitage Whitman has operated on the rest. I want to report today about fifty-eight cases, the results of which I looked up prior to coming away. There were forty-two females and sixteen males. The ages varied from seven to thirty-five, the majority of the patients being from twelve to fifteen. As far as the etiology is concerned, we have operated on all varieties. We believe this operation to be limited to ten or fifteen per cent. of the cases; namely, that number in which there is a progressive increase of the deformity. I am sure Dr. Lowman limits himself, too, in the selection of cases. I want to emphasize that we do not operate on every case of scoliosis that comes in. If we do not succeed by conservative treatment or if there is evidence of increasing deformity, we believe that fusion should be done in the hope that it will prevent a further increase of deformity. We believe that only a small percentage of scoliosis cases are paralytic. It may be only chance that Dr. Lowman showed a majority of paralytics, but in a large series the majority are idiopathic and only a small percentage paralytic.

In this group of fifty-eight cases fifty-five had satisfactory results. By that we mean that during a period of one and one-half years' to five years' observation, the degree of improvement we obtained prior to the fusion has been maintained. In three cases there were failures, that is, there was an increase of the deformity. We believe part of the failure was due to insufficient after-care. In thirty-five there was an increase in height up to six inches. In five there was no increase.

We have used beef bone grafts. I believe their use is superior to that of an autogenous graft because this method does not increase the operative strain on the patient. Beef bone provides an internal splint and in time it is absorbed and replaced by a large mass of bone.

I would like to show you just a few pictures to demonstrate how much deformity can be diminished, although that is not the important point. It is not how much we can reduce the deformity but how much we can prevent the deformity from increasing. These slides show the progress of some of the cases.

Dr. Walter Truslow, Brooklyn, N. Y.: What I wish to say I will limit to that part of the paper dealing with the exercises. The writer has shown us in the whole procedure the great advantage of minuteness of detail. Everything that he has done is done in a thorough way. He says that the very crux of treatment of these scoliosis cases is patient, step-by-step care. I can hardly do anything else than to simply approve in a general way the very careful planning of the different phases of his treatment. That impressed me immensely. The exercises correspond accurately with the principles of gymnastics for given cases. They appeal to me immensely. I do not care to enter into

the details of the operation. The principal point is the detailed and proper planning of the treatment.

DR. C. L. LOWMAN, Los Angeles, Calif. (Closing the discussion): Dr. Kleinberg must have misunderstood about the length of time we have been using this method of fusion. Our first fusion for scoliosis was in 1912. This lateral traction we did not begin to use until four or five years ago. I feel that Dr. Kleinberg has been able to use so much weight because he places his patients in such marked hyperextension. This locks the spine practically, and much of the tractile force is lost by this means. We have never been able to use over twenty-five pounds longitudinally. The spine is more mobile in flexion and in this position we can affect the lateral curves. You can readily understand the difference between the two methods: in one a child lying in a highly precarious position for work, and in the other on the bed, where lateral as well as longitudinal pull can be made and where work and training are possible. The question of morale through such a course of treatment is an important item.

Regarding our exercises for fused cases. We do not make any effort to mobilize them. We simply continue to give exercises for building them up and further combatting their static faults. If a fusion is a good one, carefully given exercises will not hurt it. I am sorry there is not time enough to discuss the matter adequately. Dr. Kleinberg has had a larger series of cases and I am glad he disagrees on some points.

# LATE END RESULTS IN UNUNITED FRACTURE OF THE NECK OF THE FEMUR TREATED BY THE BONE PEG OR THE RECONSTRUCTION OPERATION*

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The end result is the final test of any method of treatment, and the later the end result, the greater the test. The author, having had the good fortune to operate on a large number of ununited fractures of the neck of the femur, either by the bone-graft peg[1] or by his arthroplastic reconstruction operation[6], made this spring a careful check-up of the end results in all such cases seen at his office, or at the New York Post Graduate Hospital since 1909†. The experience proved very stimulating, both because the results proved even better than anticipated, and because seeing a large group of one-time patients appear years after a serious operation as active, happy and useful citizens is perhaps the surgeon's highest reward.

In ninety per cent. of the bone peg operations the results were excellent or good, and in seventy-five per cent. of the reconstruction operations. There was no mortality following the bone peg operation, and only one following the reconstruction. When we consider that ununited fracture of the neck of the femur is one of the most difficult problems in all surgery, such end results are most encouraging. The anatomicomechanical conditions, poor blood supply, sluggish osteogenesis, and difficulty of fixation because of the partial or complete intra-articular nature of the fracture are all potent adverse influences to securing satisfactory union and good functional results.

If ever radical measures are justifiable, they are indicated in the treatment of this desperate condition of non-union of fracture of the neck of the femur, with pain and marked lameness, or even inability to walk or bear weight,—a condition which, unfortunately, is not uncommon and is one of the most disabling of all traumatic lesions, since both weight-bearing and locomotion are involved.

It is interesting to note that other intra-articular fractures, such as that of the head of the radius, or of the scaphoid of the wrist, share in the frequency of non-union. But because the factors of weight-bearing and locomotion are absent, the problem is not so serious, nor the disability so great.

* Read before the Annual Meeting of the American Orthopaedic Association, Yosemite Valley, June 1927, and revised to date of publication.

† Cases operated on at General Army Hospital No. 3 during the war, or at civilian hospitals other than Post Graduate, are not included in this series.

Because of the obvious disadvantages of metal as a means of fixation, it being not only a destroyer of bone, but an inhibitor of callus formation in a region where osteogenesis is at a low grade, the autogenous bone-graft peg has come to supersede the use of metal, and is ideal for the purpose of restoring the hip as nearly as possible to its original anatomy in a large percentage of cases.

Illustrative of the untoward effects of metal spikes are a number of cases which have come to the attention of the author after such means of fixation had been used and failed (See Fig. 11). In these cases he has found the neck of the femur and the great trochanter so absolutely reamed out and destroyed by the metal nails that it was impossible to follow the usual procedure of using the dowel shaper for the peg. Instead, an unusual cross section of the tibia was required to make a peg of sufficient size to fill the hole, and the peg also had to be specially moulded to suit the irregular contour. In one case approximately three-fourths of the cortex of the entire anterior internal surface of the tibia including the crest, with all the marrow and cancellous bone that would cling to it, was required.

If early cases of fracture were painstakingly followed, and weight-bearing upon an ununited fracture prevented, the bone-graft peg could be successfully applied in an even larger percentage of cases than is now possible. Unfortunately, in a regrettable number of cases there is a history of inaccurate control of the case at the time of fracture and immediately after; and through failure to realize that union is not taking place, the patient is allowed to use the limb and wait until an extensive amount of bone has worn away from both capital and distal fragments before seeking operation. Laxity between the fragments and shortening thus become frequent complications. For these reasons the arthroplastic reconstruction operation, consisting of removing the head of the femur, performing a plastic on the stump of the neck and great trochanter, and forming a physiologic bone-muscle lever to restore abduction and prevent dislocation, must be used in place of the bone peg in many cases.

In a paper which I read before the American Medical Association in 1925, I made the statement that I believed the reconstruction operation was indicated in about ninety per cent. of the cases which are seen late, and the bone peg in only ten per cent[8]. In view of the striking good results observed in the bone peg cases which are included in this review, I wish to revise this statement, and shall in my own practice use the bone peg in a much higher percentage of cases, in the future.

Of the 146 cases reviewed, five were seen early, and treated with the Whitman abduction spica with excellent result. Thirteen cases had to be eliminated because of incomplete records. In forty-two of the 128 remaining cases, the bone peg operation was recommended; in fifty-three, the reconstruction operation. Six of the former refused operation, and nine of the latter, leaving a total of eighty patients operated on (thirty-six bone peg and forty-four reconstruction operations).

TABLE 1

UNUNITED FRACTURE OF NECK OF FEMUR TREATED BY AUTOGENOUS BONE GRAFT PEG

End results in 36 cases when patients were last seen

| Good (32 cases) | | | Fair (2 cases) | | | Poor (2 cases) | | |
|---|---|---|---|---|---|---|---|---|
| Case | Age at Op. | Time since Op.* | Case | Age at Op. | Time since Op.* | Case | Age at Op. | Remarks |
| A.B. | 60 | 15 years | M.Ko. | 54 | 7 years (marked osteo-arthritis) | M.H. | ? | Peg broke; asked to return; did not. |
| C.Cur. | 51 | 11 " | | | | | | |
| T.C. | 50 | 11 " | | | | | | |
| C.K. | 22 | 9 " | | | | | | |
| T.A. | 46 | 8 " | R.S. | 69 | Peg broke, but union took place. Last seen 6 months after operation. | L.W. | 49 | Peg broke, excessive weight of patient. Successful reconstruction operation 2 years later. |
| M.J. | 61 | 8 " | | | | | | |
| Z.M. | 54 | 6 " | | | | | | |
| L.T. | 48 | 6 " | | | | | | |
| E.S. | 50 | 5 " | | | | | | |
| E.L. | 28 | 5 " | | | | | | |
| M.C. | 50 | 5 " | | | | | | |
| A.M. | 27 | 5 " | | | | | | |
| C.Cum. | 45 | 5 " | | | | | | |
| M.K. | 13 | 4 " | | | | | | |
| M.M. | 38 | 3 " | | | | | | |
| A.W. | 35 | 3 " | | | | | | |
| J.C. | 50 | 2 " | | | | | | |
| M.G. | 32 | 2 " | | | | | | |
| E.B. | 40 | 2 " | | | | | | |
| Y.B. | 50 | 2 " | | | | | | |
| E.D.R. | 31 | 1 " | | | | | | |
| V.H. | 53 | 1 " | | | | | | |
| S.H. | 51 | 1 " | | | | | | |
| S.A. | 29 | 1 " | | | | | | |
| S.J. | 24 | when discharged | | | | | | |
| M.L. | 55 | " | | | | | | |
| E.M. | 25 | " | | | | | | |
| M.M. | 50 | " | | | | | | |
| H.R. | 29 | " | | | | | | |
| R.H. | ? | " | | | | | | |
| W.B. | 20 | " | | | | | | |
| D.B. | 45 | 6 months | | | | | | |

*Until last examination; not until 1927 in every case.

TABLE 2

UNUNITED FRACTURE OF NECK OF FEMUR TREATED BY AUTOGENOUS BONE GRAFT PEG
End Results in 17 cases traced to May, 1927

| *Reexamined in office* | | *Detailed letters received* | |
|---|---|---|---|
| *Excellent result* | *6 cases* | *Excellent result* | *5 cases* |
| 11 years after operation T.C. (50 at op.) | 1 | 15 years after operation A.B. | 1 |
| 9 years after operation C.K. (22 at op.) | 1 | 11 years after operation C C. and M.M. | 2 |
| 6 years after operation L.T. (48 at op.) E.S. (50 at op.) | 2 | 8 years after operation M.J. and T.A. | 2 |
| 5 years after operation E.L. (28 at op.) | 1 | *Good result* | *2 cases* |
| 3 years after operation M.M. (38 at op.) | 1 | 6 years after operation Z.M. | 1 |
| | | 4 years after operation M.K. | 1 |
| *Too recent to classify* | | | |
| 6 months after operation, discharged in fine condition—D.B. (45 at op.) | | *Fair result* | 2 |
| | | *Poor result* | 2* |

*One of these has excellent result from subsequent reconstruction operation.

To these eighty patients personal letters were sent in April 1927, requesting them to come to my office for examination, or if this was impossible, to write in detail regarding their present condition. It is a curious comment on New York life that many letters sent to New York addresses have been returned marked "Moved, left no address". For this reason we have been unable to trace to date nineteen of the cases in which the bone peg operation, and thirteen in which the reconstruction operation had been done. In these cases we have recorded the end result as that noted when patient was last seen.

The end results in the eighty cases are tabulated in Tables 1 to 5.

A gratifying proportion of the patients came to the office, often from considerable distance, to let us see the "wonderful result". In only two cases did a patient return for reexamination because of dissatisfaction.

TABLE 3

SUMMARY OF END RESULTS FOLLOWING BONE GRAFT PEG OPERATIONS
36 cases

| GOOD—32 (90%) | Cases | FAIR—2 | Cases | POOR—2 | Cases |
|---|---|---|---|---|---|
| 15 years after operation | 1 | 7 years after operation | 1 | Peg broke | 1 |
| 11 " " " | 3 | 6 months " " | 1 | Peg broke | 1 |
| 9 " " " | 1 | | | 1 subsequently treated successfully by reconstruction operation; 1 by another peg-graft (listed under good results). | |
| 8 " " " | 2 | | | | |
| 6 " " " | 2 | | | | |
| 5 " " " | 5 | | | | |
| 4 " " " | 1 | | | | |
| 3 " " " | 1 | | | | |
| 2 " " " | 4 | | | | |
| 1 " " " | 4 | | | Peg broke. Patient asked to return. Did not. | |
| 6 months " " | 1 | | | | |
| When discharged | 7 | | | | |

TABLE 4

UNUNITED FRACTURE OF NECK OF FEMUR TREATED BY AUTHOR'S RECONSTRUCTION OPERATION

End results in 44 cases, when patient was last seen

| GOOD (33) 75% | | | FAIR (3) | | | POOR (5) | | |
|---|---|---|---|---|---|---|---|---|
| Case | Age at Op. | Time since Op.* | Case | Age at Op. | Time since Op.* | Case | Age at Op. | Remarks |
| C.W. | 63 | 8 years | B.B. | 50 | 5 years | A.B. | 55 | |
| M.M. | 21 | 8 " | M.G. | 53 | 3 years compensitis | M.D. | 51 | Malignant |
| O.B. | 50 | 6½ " | | | | J.E. | 63 | |
| H.W. | 19 | 6 " | H.L. | 50 | 4 years; adhesions; manipulation recommended | J.McC. | ? | Did not have post-operative massage. |
| G.G. | 57 | 5 " | | | | | | |
| H.S. | 26 | 5 " | | | | | | |
| L.W.** | 52 | 5 " | | | | | | |
| S.L. | 44 | 4 " | | | | L.P. | 50 | Did not cooperate postoperatively. |
| H.H. | 32 | 3 " | | | | | | |
| L.F. | 52 | 3 " | | | | | | |
| G.R.D.† | 33 | 3 " | | | | | | |
| C.B. | 33 | 3 " | | | | | | |
| K.M. | 46 | 3 " | | | | | | |
| W.S. | 21 | 2 " | | | | | | |
| M.L. | 54 | 2 " | | | | | | |
| H.H. | 52 | 2 " | | | | | | |
| D.McG. | 67 | 2 " | | | | | | |
| I.S. | 47 | 2 " | | | | | | |
| E.D. | 32 | 2 " | | | | | | |
| D.B. | 48 | 2 " | | | | | | |
| W.D. | 49 | 1 " | | | | | | |
| K.C. | 52 | 1 " | | | | | | |
| B.W. | 51 | 1 " | | | | | | |
| P.A. | 45 | 1 " | | | | | | |
| F.G. | 25 | 6 months | | | | | | |
| A.F.R. | 56 | 6 " | | | | | | |
| N.N. | ? | 5 " | | | | | | |
| H.B. | 39 | when discharged | | | | | | |
| L.F. | 40 | " | | | | | | |
| F.P. | 38 | " | | | DEATHS: 2 within | one week of | operation | |
| M.S. | 42 | " | | | 1 of these from | chronic nep | hritis | |
| P.S. | 58 | " | | | | | | |
| C.S. | 46 | " | | | TOO RECENT TO JUD | GE RESULT: | 1 case now | in hospital |

*This represents time between operation and last examination of the patient (not 1927 in every instance).
**Reconstruction after bone graft had broken, due to excessive weight of patient.
†After bone graft operation performed elsewhere had failed.

TABLE 5

SUMMARY OF END RESULTS FOLLOWING RECONSTRUCTION OPERATION
44 cases

| | | | |
|---|---|---|---|
| *Excellent* | *11 Cases* | *Fair* | *3 Cases* |
| 8 years after operation | | 5 years after operation | 1 |
| C.W. and M.M. | 2 | 4 years after operation | 1 |
| | | 3 years after operation | 1 |
| 6 years after operation | | | |
| O.B. and H.W. | 2 | *Poor* | *5 Cases* |
| | | NOTE: 2 of these did not come for postoperative massage; 1 developed malignancy. | |
| 4 years after operation | | | |
| S.L. | 1 | | |
| 3 years after operation | | *Deaths* | |
| H.H., G.R.D., K.M. | 3 | 2: within one week of operation, 1 from chronic nephritis. | |
| 2 years after operation | | | |
| D.McG. and M.L. | 2 | *Too recent to judge result* | |
| | | 1 case now in hospital | |
| 1 year after operation | | | |
| P.A. | 1 | | |
| *Good* | *22 Cases* | | |
| 5 years after operation | 3 | | |
| 3 years after operation | 2 | | |
| 2 years after operation | 5 | | |
| 1 year after operation | 3 | | |
| Less than 1 year after op. | 9 | | |

Those who could not come to New York for the check-up examination sent letters, stating in detail the degree of function and their present activities. One of the latter wrote that she was spending the summer climbing trails in Yosemite Valley, surely a strenuous test of function. This was a case in which the autogenous bone-graft peg had been used.

BONE PEG OPERATION

In setting up the standards for results, the following definitions were used:

*Excellent:* Nearly normal mobility, normal stability, use of neither crutch nor cane, and strenuous postoperative activities such as dancing, sailor's duties, carpenter's activities, and ability to walk several miles without pain or fatigue.

*Good:* Nearly normal mobility, normal stability, use of neither cane nor crutch, and resumption of usual activities. Absence of pain and fatigue.

*Fair:* Very satisfactory result, but patient relies on cane. In several instances the cane is not used about the house, but only when walking on uneven ground. Slight pain or fatigue.

*Poor:* Patient has to use crutch, or has considerable pain and fatigue.

No mortality followed the bone peg operation, and excellent or good results were obtained in ninety per cent. of cases. This should afford reassurance to both patients and physicians who are sometimes prone to regard

**Reconstruction operation and last examination of the patient (not 1927 in every instance).
†After bone graft operation performed elsewhere had failed.

operative interference as an extremely dangerous risk. If the cases are properly selected, and *the technique carried out with requisite delicacy and precision*, the results will be most gratifying.

As shown in the tables, there were twenty-nine good or excellent results, two fair results, and in three cases the bone peg broke; in one case because of the excessive weight of the patient, and in one during a drunken spree. The first patient was subsequently given an excellent functional result by means of the reconstruction operation, and the second by insertion of another bone peg. The third patient was advised to return for insertion of a second graft, but refused.

### RECONSTRUCTION OPERATION

Following the reconstruction operation, there has been only one death in forty-four cases. (One directly attributable to chronic nephritis is not considered an operative mortality.) One case has been so recently operated on (two months), that the end result cannot be definitely classified, although the patient gives evidence of a very satisfactory recovery.

In thirty-three cases the result has been good or excellent. Seven of the excellent results were observed personally on reexamination during May, 1927; the eighth writes that function is extremely satisfactory. She is doing all her own housework, and engaging in many outside activities. In twenty-five cases the result has been good; in three, fair; and in five, poor.

One of the five cases in which the result was not satisfactory developed malignancy in the hip and lung three months after operation. A second did not receive postoperative massage. This was a compensation case and emphasizes the difficulties occasionally encountered in dealing with certain industrial litigation situations. Another patient refused to cooperate in the postoperative treatment; otherwise she would have had at least a fair result. The last two cases both illustrate by contrast *the importance of postoperative massage*, which serves to break up adhesions, to restore muscle control, and to stimulate the patient's confidence, which after so disabling an injury as fracture of the neck of the femur is at first practically nil.

### ILLUSTRATIVE CASES

Case 1. E. L., carpenter, twenty-eight years old. Fell twenty feet from scaffolding. Leg put up in Hodges' splint for one month. Seen by us four months after accident, walking with crutches. X-ray showed ununited fracture of neck of femur (Fig. 1).

*Bone-graft peg* operation, October, 1922.

End result, May, 1927: Doing regular carpenter's work, climbing ladders and scaffolding. Function absolutely normal. No lameness, no pain. Seen in office (Figs. 2 and 3).

Case 2. M. K., girl, thirteen years old, slipped on sidewalk. Plaster applied from chest to toes, straight down, for five weeks. Then she consulted us. All motions restricted and painful. Hip flexed thirty degrees. Push and pull produced false point of motion. X-ray showed ununited fracture through cyst in neck of right femur (Fig. 4).

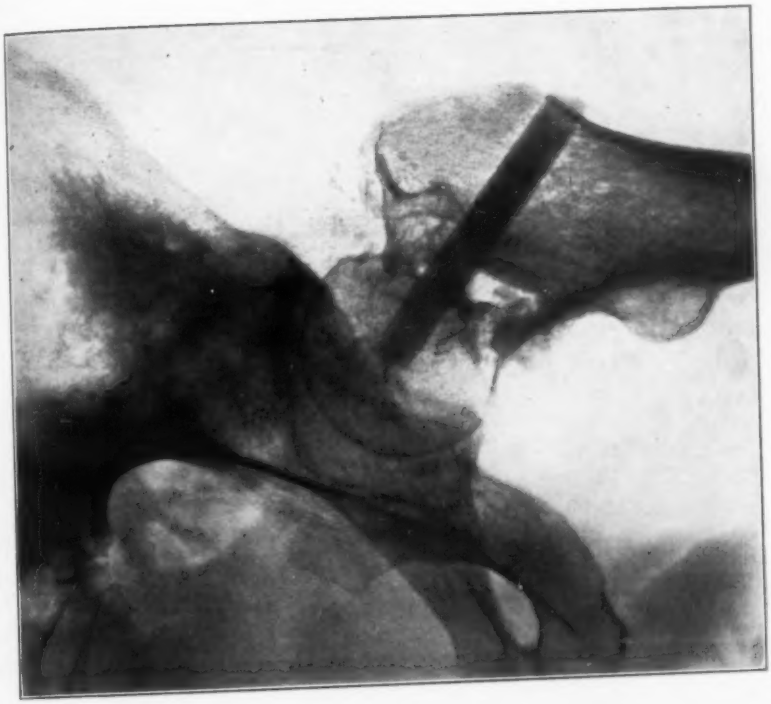

FIG. 2
Postoperative x-ray, Case 1, nine months after operation.

FIG. 1
Pre-operative x-ray, Case 1.

FIG. 4
Pre-operative x-ray, Case 2.

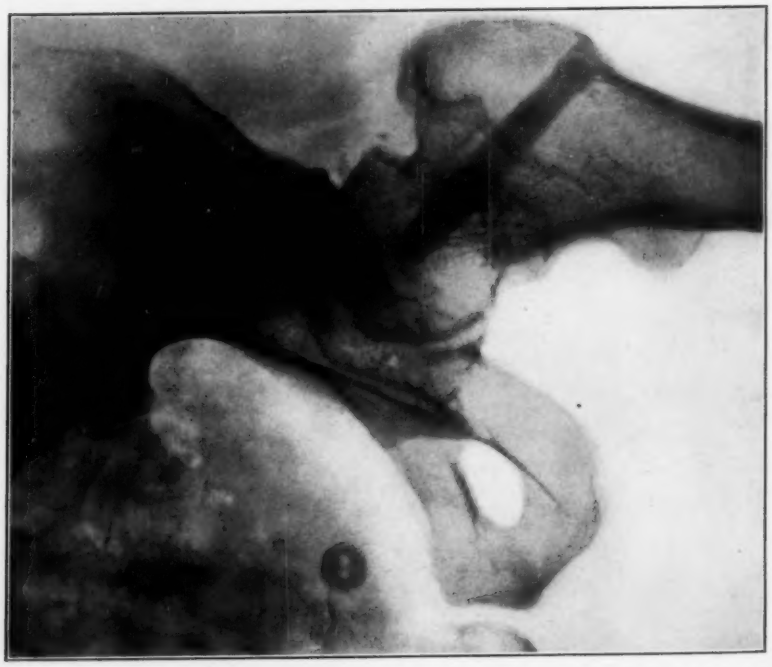

FIG. 3
Postoperative x-ray, Case 1, six years after operation.

Fig. 6
Pre-operative x-ray, Case 4.

Fig. 5
Postoperative x-ray, Case 2, four months after operation. Note callus formation.

*Bone-graft peg* February 4, 1923. X-ray, June, 1923, showed good union (Fig. 5).

End result, April, 1927: Described in letter as "entirely satisfactory. Used one crutch for two months after leaving hospital. Then used leg as before accident, and have continued to do so without pain or limp."

CASE 3. Z. M., woman, aged fifty-four years, slipped and fell. Put in Buck's extension for six weeks. Came to us with severe pain, and "sensation of slipping on rubber when walking". History of several previous fractures in other parts of body, all of which had healed well. X-ray showed irregular, transverse fracture of neck of femur, with moderate upward and inward displacement of the shaft.

*Bone-graft peg* June 8, 1921, eight months after accident.

End result, June, 1927: On her feet most of the day and has no pain or fatigue following constant use of injured leg. Walks easily and for considerable distances without cane.

CASE 4. L. T., salesman, aged forty-eight years, struck in railroad collision. Treated for torn muscles, *without x-ray*. Later in cast, abducted, for two months. Non-union. Seen by us six months after accident (Fig. 6).

*Bone-graft peg*, June, 1921. X-ray, September, 1921, showed good union and bone growth.

End result, September, 1927: Perfect result. Motion free and painless in all directions. Patient does active calisthenics daily. Seen in office (Figs. 7 and 8).

CASE 5. L. W., woman, aged forty-nine years, fell from trolley. Fracture set twelve times; twelfth time Steinmann pin used. Seen by us six months after accident. Non-union.

*Bone-graft peg*, December, 1919. X-ray two months later shows bony union and fragments in good alignment. March, 1920, peg broke due to excessive weight of patient.

*Reconstruction operation*, July, 1922.

End result, May, 1927: Patient writes that she has married and does all her own housework; goes upstairs easily. Finds some difficulty in going downstairs. Experiences only slight fatigue.

CASE 6. C. K., man, aged twenty-two, auto mechanic. Hit by auto while walking. Thrown thirty feet, and hip wedged between curbing and wheel of another machine. No treatment for four days. Then treated for rupture of ligaments, *without x-ray. Two months after accident, x-ray in one position showed no fracture.* Patient was going about on crutches and was accused of malingering in attempt to avoid being drafted into army. Went to masseur, but no benefit resulted. Practically gave up hope. Six months after accident, met by chance a naval doctor, who suggested fracture, and took x-rays in several positions. Ununited fracture revealed. This case is unusual in that there was no pain or swelling, although there was absolute instability at the hip, and the patient could not walk. Referred to author eight months after the accident.

*Bone-graft peg operation*, April, 1918. Three weeks after removal of cast discarded cane, and experienced only slight pain. This disappeared within a few days and has never recurred.

End result, October, 1927 (Seen in office), (Fig. 9). Mobility and stability absolutely normal. Cannot tell which is operated leg as patient walks about. Daily work calls on every possible use of leg (lifts motors and rear ends, climbs ladders, and is also under and over cars). Patient notices no difference between function of legs. Slight shortening (one and one-quarter inches) is offset by raised heel.

CASE 7. M. J., a woman, aged sixty-one years, fell on hip in January, 1919. Week later leg put up in cast. Leg swelled and cast removed. Later put in extension frame for three weeks. Severe pain. X-ray taken March 3. Balkan frame applied for eight weeks; then Thomas splint. Massage. First seen by us in November, 1919, when she was walking with Thomas splint and cane, and became easily fatigued. Considerable shortening. Non-union.

*Bone-graft peg operation*, November 17, 1919.

FIG. 7

Postoperative x-ray, Case 4, one year after operation. Note tibial dowel peg graft in place, and callus formation.

FIG. 8

X-ray five years after operation, Case 4. Complete solidification of the neck with realignment of the bone structure. Outline of bone-graft peg disappearing because of amalgamation.

FIG. 9

Postoperative x-ray, Case 6, nine years after operation.

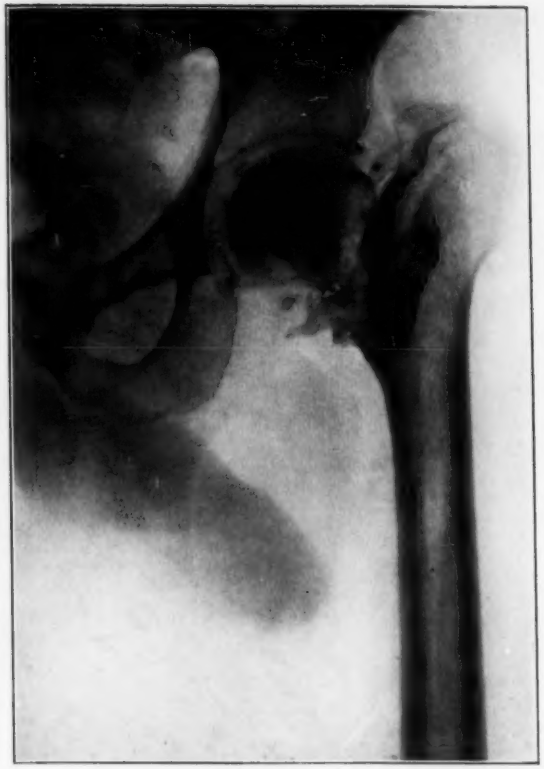

FIG. 10

Pre-operative x-ray, Case 8, one year after reconstruction operation. Patient has resumed full activities, and is even able to ride horseback.

End result, April, 1927: Patient writes that she has had arthritis since 1924, but in spite of this walks without pain or fatigue. She uses a cane.

This case is interesting because of the variety of mechanical treatment that had been tried without success. In view of the patient's age at the time of operation, the result is very satisfactory.

CASE 8. Mr. P. A., forty-five years old, fell and was caught under a horse. In bed without treatment for twenty-two days. Traction one day. Cast forty-five days. Massage. Non-union. Two and one-half years later consulted author. Had difficulty in getting about, became fatigued easily, and had occasional pain radiating from hip to knee. X-ray showed non-union (Fig. 10). Shortening.

*Reconstruction operation*, November, 1926.

End result, November, 1927: Patient able to ride horseback. No pain or fatigue. Function normal. Mexican general who leads very active life.

CASE 9. Mrs. O. B., a woman, aged fifty years, fell from chair on which she was standing, and fractured hip. Buck's extension and cast in abduction. Began to bear weight in twelve weeks. Hip painless and apparently solid. One year after accident began to limp. Consulted us three years after accident, when all motion was painful. Walking with crutch. X-ray showed non-union.

*Reconstruction operation*, October, 1920.

End result, October, 1927: Walks without limping, does own housework, climbs step-ladders without fatigue. Recently did mountain climbing without ill effect. Abduction thirty degrees, then free movement of pelvis. Flexion of femur to ninety degrees. Adduction normal.

CASE 10. Mr. C. B., aged thirty-three years. Roll of paper fell on him. Buck's extension. Consulted us six months after accident. All movement very painful, and patient walking with crutches.

*Reconstruction operation*, March, 1924.

End result, May, 1927: Patient writes that he has good use of hip and knee, and works without fatigue. Does not use cane.

CASE 11. Mrs. L. F., fifty-two years old. Slipped on floor one year before our examination. Had been treated with traction six weeks, and used crutches for several weeks after. When we saw patient, extremity was markedly swollen, and patient walked with limp. X-ray showed non-union.

*Reconstruction operation*, July, 1924.

End result, June, 1927, on reexamination, good function.

CASE 12. Mrs. G. G., fifty-seven years old. Fell several feet. Traction for six weeks. In bed three weeks longer with massage and manipulation. Told to bear weight at end of nine weeks. Could not do so because of pain. Seen by us six months after accident. Could not walk or lift leg. Severe pain. X-ray showed non-union.

*Reconstruction operation*, May, 1922.

End result, June, 1927: "Everlastingly grateful to you for making it possible for me to go about as well as before my accident. I walk as well as ever and can do whatever I wish. I have not used a cane for three years."

CASE 13. Miss H. H., fifty-two years old. Fell and fractured neck of femur six months before we saw her. Cast applied soon after accident. When we saw her, she could not bear weight, and pain wakened her at night. Some pain during day. Non-union.

*Reconstruction operation*, December, 1925.

End result, April, 1927: Walking without cane, and has resumed practice as masseuse. Flexion to ninety-five degrees. Abduction ninety per cent. normal. Rotation one-half normal.

CASE 14. Mrs. C. W., sixty-three years of age. Old fracture of neck of femur close to head. Shaft displaced upward and inward. Non-union. Operations elsewhere with insertion of metal spikes. No relief. Walking with crutches.

April, 1919, *three nails removed*, and *reconstruction operation* performed.

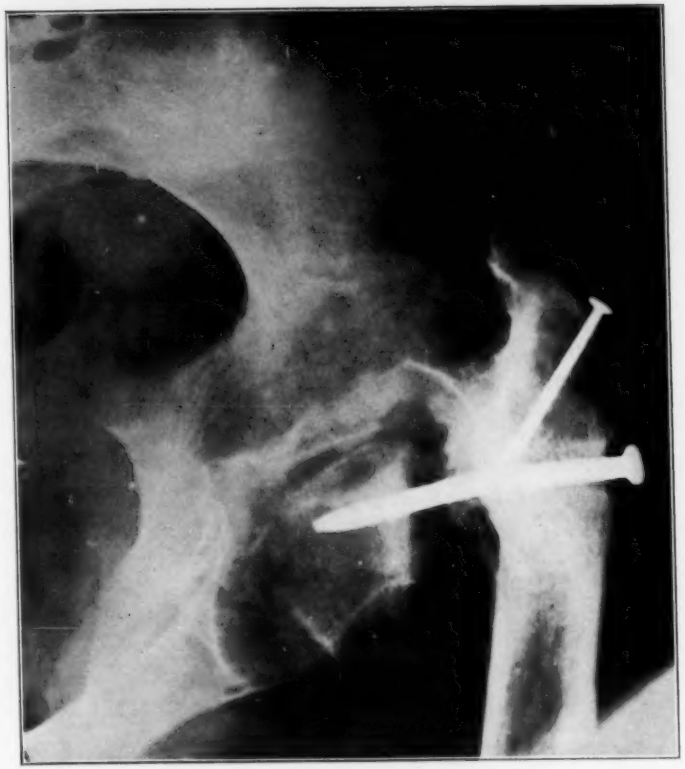

FIG. 11

Pre-operative x-ray, showing the inefficacy of inserting foreign bodies, such as metal nails. Owing to the damage done by the nails, it was necessary to do a reconstruction operation, following which firm union and good motion were secured (Case 15).

FIG. 12

Pre-operative x-ray, Case 16. Patient sixty-seven years old when operated upon. Result two years after reconstruction operation excellent.

FIG. 13

X-ray six years after reconstruction operation (Case 19). Patient dances, plays tennis, and does regular work. No pain or limp. Does strenuous calisthenics and notices no difference in function of two legs.

FIG. 14

X-ray four years after reconstruction operation (Case 20). Patient has resumed active duties. No pain or limp.

End result, May, 1927: Walks without cane and gets about house easily. "What you did for me has given me all these years of comfort."

CASE 15. Mr. W. S., aged twenty-one years. Limped at twelve years. Told he would outgrow it. Fractured femur while playing basket-ball. Operated upon at once elsewhere. Non-union. Cast continued for five months; then same surgeon operated a second time. Patient came to us, unable to bear weight two years after accident. X-ray showed non-union and nails (Fig. 11).

December, 1925, *removal of two nails*, and *reconstruction operation*.

End result, October, 1927, on reexamination very good. Patient has resumed active work.

CASE 16. Mrs. D. McG., sixty-seven years old. At time of fracture treated with short cast and splints, without abduction. Came to us on crutches six months later (Fig. 12).

*Reconstruction operation*, March, 1925.

End result, January, 1927, excellent. Reexamined. Good, painless motion in all directions.

CASE 17. Miss M. M., twenty-one years old. Fell from horse five years before our examination. Three nails inserted at operation two months after accident. Wore brace for one year after that. Then hip gave so much trouble that nails had to be removed. Unable to bear weight. When seen by us, loose ununited fracture.

*Reconstruction operation*, December, 1919. Nails removed. Infection following operation, in region of nails used at previous operation.

End result, May, 1927, excellent. Dances and uses hip actively. No pain.

CASE 18. Miss K. M., forty-six years old. Fell on ice two years before our examination. Thomas splint for six weeks, then rest in bed for four weeks. Patient could not bear weight. Crutches and wheel chair for six months. Then advised to have hip wired. Refused to do so. Consulted us.

*Reconstruction operation*, May, 1924.

End result, April, 1927: Patient writes that three months after operation she could use leg well, and the present condition is "entirely satisfactory". Does not use cane, and can walk a mile without fatigue.

CASE 19. H. W., nineteen years old. Fell six feet in gymnasium. Could not walk home. Ten days later x-rays taken, and patient put up in abduction plaster for five weeks. Bore weight at end of ten weeks. Two osteopathic treatments. Consulted us one year after accident, walking with marked limp. X-ray showed non-union with considerable wearing away of the neck.

*Reconstruction operation*, February, 1921.

End result, May, 1927: Able to dance, play tennis and do regular work. Voluntary abduction and hyperextension absolutely normal. Slight limitation of flexion (Fig. 13).

CASE 20. S. L., forty-four years old. Hamilton splint two weeks; plaster spica to ankle three weeks; massage eight weeks. Patient came to author eight months after accident, limping, unable to flex thigh, and with much pain. X-ray showed non-union.

*Reconstruction operation*, August, 1923.

End result, June, 1927, excellent. Flexion to right angle. Abduction to within twelve degrees of normal. Walks without limp. Goes up and down stairs easily. Has resumed regular activities (Fig. 14).

## SUMMARY

The end results in 146 cases of ununited fracture of the neck of the femur were reviewed. Five were seen early, and treated with the Whitman abduction spica with excellent result. Thirteen cases had to be eliminated because of incomplete records. In forty-two of the remaining 128 cases, the bone peg operation was recommended; in fifty-three, the reconstruction

operation. Six of the former refused operation, and nine of the latter, leaving a total of eighty patients operated on (thirty-six bone peg and forty-four reconstruction).

In ninety per cent. of the bone-peg operations the results were excellent or good, and in seventy-five per cent. of the reconstruction operations. The interval between the time of operation, and that of the last examination varied from a few months to fifteen years. Function is usually good within six months after operation. When we consider that ununited fracture of the neck of the femur is one of the most disabling of all traumatic lesions, and one of the most difficult problems in surgery because of the anatomicomechanical conditions and because of the erosion that has so often taken place before the surgeon is consulted, such end results are most encouraging.

Failure to take x-rays at the time of the accident, or the taking of x-rays in only one position accounts for many unfortunate cases of delay in correct diagnosis and treatment. The greater this delay, the greater the difficulty of the problem with which the surgeon is eventually confronted.

## REFERENCES

To other contributions by the author on the same subject.

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2. The Inlay Bone Graft as a Treatment of Ununited Fractures. Am. J. Surg., XXVIII, 21, Jan. 1914.
3. Original Surgical Uses of the Bone Graft. Surg. Gynec. Obstet., XVIII, 699, June, 1914.
4. The Bone Graft Peg in the Treatment of Fractures of Neck of Femur. Ann. Surg., LXII, 85, July 1915.
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6. Treatment of Fracture of the Neck of the Femur. Am. J. Orthop. Surg., XVI, 493, Aug. 1918.
7. Reconstruction Surgery. International Clinics, Series 35, Philadelphia, J. B. Lippincott Co., II, 225, 1925.
8. Reconstruction and Plastic Operations on the Hip. J. Am. Med. Assn., LXXXV, 1345, 1925.
9. Ununited Fractures of the Hip. Internat. J. Med. Surg., XL, February, 1927.

## DISCUSSION

Dr. M. S. Henderson, Rochester, Minnesota: The tendency has been for us to drift away from the bone pegging operation to some of the so called reconstruction operations. It is my opinion that we have drifted too far in that direction.

The bone pegging operation in old fractures of the neck of the femur is a very difficult one It must be approached with the utmost care and preparation. The selection of cases, of course, is the all important thing and I have been struck by the number of young people in the group comprising Dr. Albee's table here. The younger the patient, the better the chance of a good result.

There are two points I should like to mention that Dr. Albee did not have time to say much about,—the duration of the non-union, and the age of the patient. The

duration of the non-union has little to do with the bone pegging operation, providing some of the neck of the femur is left. The best case I have had was a physician fifty years of age who had a non-union for three years before the operation. Now, for all intents his hip is a normal one and he has full range of motion. The age of the patient is important and, although not an absolute rule, I think that the bone pegging operation should not be undertaken in a patient over fifty-five years of age.

The technique must be most carefully carried out. I think that most of my failures have been due to the fact that I did not freshen the bone ends enough and then did not get accurate bony contact. If a gap is left between the head and the neck of the femur and the bone peg merely bridges this gap, the chances are that the bone peg will absorb and the operation be a failure. Bony contact of the fracture surfaces is essential.

The reconstruction operation in which the head of the femur is sacrificed should be reserved for those cases in which the bone pegging operation is not possible, due to the age of the patient or to too great absorption of the neck of the femur.

The postoperative care is extremely important in these cases. Union is very often slow in developing and, if weight-bearing is permitted too soon, what little union there is will break down and non-union again occur. We cannot set an arbitrary time for this; some patients must be protected for a year or more, while others are able to bear weight and walk in six months. The only way to control this is by the x-ray, and the roentgenogram must show sufficient calcification to warrant weight-bearing.

Dr. Ellis Jones, Los Angeles, Calif.: We have had operative experience in thirty-eight cases of non-union of the neck of the femur. We have used autogenous bone pegs, following the Albee technique, in twenty-one patients. The youngest patient was twenty-one years of age and the oldest fifty-eight. One operating room infection occurred with a poor result. One graft was fractured at three months because of inadequate plaster fixation. Absorption of a graft occurred seven months after operation. Eighteen patients obtained thoroughly good functional results.

Seventeen reconstruction operations for non-union have been done according to the Whitman method with good results. I have had no experience with the Albee reconstruction operation. The functional results obtained from a successful bone transplantation are far superior to any reconstruction operation, and bone transplantation should be the operation of choice. Simple excision of the head, preferably through a posterior incision, followed by a long period of freedom from weight-bearing with a caliper splint, as advised by Sir Robert Jones, will give equally good results as any reconstruction operation. The operation is much less of a shock, especially if the head be removed posteriorly. A caliper abduction splint is worn for six months. The trauma of the reconstruction operation in the aged makes it a more serious operation than the excision of the head. In the older patients, unfavorable osteo-arthritic changes inevitably take place and a hip joint reconstructed by any method does become increasingly painful as the osteo-arthritis progresses.

The radiograph is no guide to the viability of the head. We have seen the regeneration of a new and capable neck following a bone transplantation. Complete regeneration occurred in four months and in nine months. The radiograph is the only index to the length of time that postoperative plaster fixation will be required. It seems absurd to indicate any definite period of fixation in the individual patients. One of the best results obtained was in a patient in whom plaster fixation was required for eleven months.

Dr. G. E. Bennett, Baltimore, Md.: Practically everything I wished to say in this discussion has already been mentioned by the two previous discussors.

I think the most striking thing in Dr. Albee's presentation is the fact that if the patients are young enough they do very well.

Regarding the question of union, regardless of the operation you select, whether it be a bone pegging operation or a reconstruction operation, each case is a test unto itself. I had a series of five or six cases of young adults, under fifty years, with fracture of the neck of the femur in which we operated and did a pegging operation, feeling it was

indicated. I was just getting ready to publish the results when one of my star cases who had been walking for a year began to develop pain with slight absorption of the head. The bone peg was removed and it was found that a section had passed through the trochanter up into the neck and was very much eroded. Where it passed into the head it was in just the same condition as when it was put in. I feel that you cannot absolutely tell what the result is going to be until after a lapse of two years.

# Correspondence

*To the Editor,*
*The Journal of Bone and Joint Surgery*

Dr. Murk Jansen has called my attention to the fact that I omitted mention of his monograph "Feebleness of Growth and Congenital Dwarfism", in which he carefully describes congenital deficiency of the clavicle:

JANSEN, MURK: Feebleness of Growth and Congenital Dwarfism, London, 53, 1921.

If possible, I would appreciate it if a note could be made in the *Journal* concerning this omission from my article (Congenital Deficiency of the Clavicle. IX, 545, July 1927).

Yours very truly,
(Signed) Earl D. McBride

October 20, 1927
Oklahoma City, Oklahoma

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*To the Editor,*
*The Journal of Bone and Joint Surgery*

May I call your attention to the fact that, in a paper recently published by Dr. S. A. Grantham in *The Journal of Bone and Joint Surgery*, October 1927, the author credits to me opinions in reference to heliotherapy and its results, but which in reality were a report of my impressions of the methods and principles presented by Dr. Rollier, as observed during my visit at his clinic in Leysin. My own opinions are expressed in the closing part of my paper which was published in Surgery, Gynecology and Obstetrics in June, 1927 (XLIV, 743).

Very sincerely yours,
(Signed) Nathaniel Allison

November 28, 1927
Boston, Mass.

# News Notes

Dr. Walter G. Stern has moved his office to 1304 Hanna Building, Euclid Avenue at 14th Street, Cleveland, Ohio.

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An Orthopaedic Department has been formed at the Petersburg Hospital, Petersburg, Virginia. Dr. Thomas Wheeldon is in charge of the Department.

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The next meeting of the **Clinical Orthopaedic Society** will be held in Memphis, Tennessee, on January 9 and 10. As announced in the last issue of the *Journal* this meeting was planned for November 9 and 10, but it was necessary to change the dates to January 9 and 10.

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At the meeting of the **Chicago Orthopaedic Club,** held in the Crerar Library Building on November 11, the following program was presented:

Scoliosis, by Dr. Jacob Myers.
Brachial Birth Palsy, by Dr. E. D. Hauser.
Demonstration of the Arthroscope, by Dr. Philip H. Kreuscher.
Diagnosis and Treatment of Sacro-iliac Subluxation, by Dr. H. Hoyt Cox.

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On November 17, the annual **Clinic for Crippled Children** was held in Yakima, Washington. This clinic is fostered by the Yakima Rotary Club, the details of the work being carried out by the Visiting Nurses.

The clinic was held in the Sisters' Hospital by Dr. C. F. Eikenbary, of Seattle. Over fifty children were examined, many of whom will later be admitted to the Children's Orthopaedic Hospital in Seattle.

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The Seventh Annual Meeting of the **International Society for Crippled Children** is to be held in Memphis, Tennessee, on February 13, 14 and 15.

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**A Clinic for Crippled Children** was held at Amarillo, Texas, on November 1, sponsored by the Lions Club of Amarillo, assisted by the Potter County Medical Society and the Oklahoma Society for Crippled Children. Dr. Earl D. McBride of Oklahoma City was the examining surgeon. One hundred and twelve children were examined. There is now in prospect the formation of a Texas State Society for Crippled Children and the state presents a real need for such an organization.

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At the meeting of the Executive Committee of the **British Orthopaedic Association** on July 12, 1927, Mr. A. S. B. Bankart, M.Ch., F.R.C.S., was appointed as the British Member of the Editorial Committee of the *Journal.* Mr. Harry Platt, M.S., F.R.C.S., was appointed as Editorial Secretary and Mr. George Perkins, M.C., F.R.C.S., 102 Harley Street, London, W.1., was made a member of the Advisory Editorial Staff. These appointments are in line with the newer plans and the development of the *Journal* and will make for a more efficient working basis of the two Associations in their relation to the *Journal.*

**The Travel Study Club of American Physicians** is planning a study tour for 1928 to Spain, the Riviera, Northern Italy, Budapest, Vienna, Munich, and Bavarian Health Resorts, Berlin and Hamburg, visiting clinics and medical institutions. The trip will start June 30, 1928, and will take two months. Inquiries for further details may be addressed to the Secretary, Dr. Richard Kovacs, 223 East 68th Street, New York City.

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**The Seattle Orthopaedic Society** will hold its Annual Clinics on February 24 and 25, 1928. The clinics are to be conducted by Dr. H. Winnett Orr, and will be upon osteomyelitis and compound fractures. These clinics will consist of lectures, operations and discussion of cases presented by visiting doctors.

The Society is fortunate in securing Dr. Orr, as he operated on several osteomyelitis cases in Seattle last summer, and at these clinics he will demonstrate the diagnosis, operation, and end results.

The Seattle Orthopaedic Society extends an invitation to all members of the profession who are interested in this work.

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**The Pacific Northwest Orthopaedic Society** held its summer clinical meeting in Portland, Oregon, on September 17. In the morning a dry clinic was presented by Drs. McClure, Dillehunt and Lucas, the staff of the Shriners' Hospital, and included a review of cases of stabilizing operations upon paralytic feet, osteoclasis for rachitic deformities and a symposium on scoliosis.

After a lunch with the patients, a clinic was conducted in the Good Samaritan Hospital by Drs. Akin and Carlsen, which included a discussion of Colles' fracture, various end results in spinal bone graftings and arthroplasties of the hip.

The meeting concluded with a dinner at the University Club. Seattle was selected for the two meetings of the new fiscal year. Dr. Wyckoff of Seattle was elected president and Dr. Jefferys, also of Seattle, secretary of the Society for the new year.

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The meeting of the **Interurban Orthopaedic Club** was held in Toronto, October 28 and 29. Operating technique at the Hospital for Sick Children was excellent in every way. The members were shown the museum and the pediatric laboratories; and Dr. Alan Brown gave a most interesting talk, showing the curative value of sunlight, measured by its effect upon rachitic rats. These rats were bred from rachitic parents, in which parents the rachitis had been produced by feeding and confinement. He showed that sky-shine has one-half to two-thirds the curative value of sunlight. He also showed that at Toronto the sunlight in December, January, and February has much less curative effect than in March and April when the sunlight rapidly increases in its curative qualities to that of the summer. He has found that the much advertised forms of glass obstruct a large proportion of the curative light. On Friday afternoon the end results of an interesting group of cases were shown by Drs. D. E. Robertson, A.B. LeMesurier, R. I. Harris, J. L. McDonald, and W. E. Gallie. A case of tendon fixation thirteen years after operation was shown and the effect it had produced in diminishing cavus of the foot as well as developing an excellent foot which could bear the whole body weight on the toe. An extremely interesting paper which dealt with bacilluria in tuberculosis of bones and joints was given by Dr. R. I. Harris, and another explaining a new and apparently excellent operation for recurrent dislocation of the shoulder by Dr. LeMesurier. On Saturday morning at the Toronto General Hospital Dr. Gallie did a very interesting operation for non-union in septic fracture of the tibia. Dr. Clarence Starr showed extremely interesting cases of spondylolisthesis, and Dr. Harold Wookey showed cases of Gritti-Stokes' amputation for Berger's disease. Dr. F. N. G. Starr showed a most unusual case of fracture dislocation of the spine. The members were then taken on a tour through the Connaught Laboratories where all the insulin is made for the British possessions.

**The Eastern States Orthopaedic Club** met in Baltimore for a three days' session on November 3, 4 and 5. Full membership was present and a most interesting time was enjoyed. The program was as follows:

Thursday, November 3, 1927, Johns Hopkins Hospital.

The Brachial Plexus Block. *By Dr. E. M. Hanrahan, Jr.*
Dead Fascia Grafts.
Myositis Ossificans Progressiva. *By Dr. A. R. Koontz.*
Physiological Problems in the Healing of Bone. *By Dr. R. W. Johnson, Jr.*
Pathological Fractures.
Case Reports. *By Dr. Edwin Weinberg.*
Spinal Cord Tumors. *By Dr. Walter Dandy.*
Hexylresorcinal as an Antiseptic. *By Dr. Raymond Lenhard.*

Friday, November 4, 1927, Johns Hopkins Hospital.

Recurrent Dislocation of the Shoulder.
Relaxed Knee Joints.
Fracture of the Neck of the Femur. (Case Report.)
Congenital Deformities of the Knee. *By Dr. George E. Bennett.*
Exhibition of a case of Trichinosis with Associated Osteomyelitis. *By Dr. John B. Hopkins.*
Report of Case. *By Dr. Raymond Lenhard.*
Dislocation of the Tarsal-Scaphoid.
An Unusual Fracture of the Neck of the Femur. *By Dr. Guy W. Leadbetter.*
Sacro-iliac Test.
Sugar Tolerance Tests in Arthritis.
Case Reports. *By Dr. I. W. Nachlas.*
Report of case of Actinomycosis. *By Dr. M. Gelman.*

Saturday, November 5, 1927, Children's Hospital School.

Experiments with Foreign Material in the Region of the Epiphyseal Cartilage Plate, of Growing Bones, to Increase Their Longitudinal Growth. *By Dr. Harold R. Bohlman.*
Report of Experiments of Joint Cultures in Infectious Arthritis. *By Dr. Alfred R. Shands.*
A study of the Lymphatic System in Bone. *By Dr. Aldridge Campbell.*
Post-operative Results of Torticollis. *By Dr. Raymond Lenhard.*
Ward Rounds. *By Dr. William S. Baer.*

There was such a variety of things shown that it is difficult to mention one without mentioning them all. One of the interesting things shown was the work on the use of dead fascial grafts. This is still in the experimental stage, but the possibilities of this form of graft, when its sterilization can be prepared, are very great.

Among many other things on the program can be mentioned several cases of relaxed knee joints which were shown by Dr. Bennett. These were mostly in athletes who were much incapacitated until they had had an operation on the capsule reported elsewhere by Dr. Bennett. The results were very good.

On the last day of the meeting in the Children's Hospital, Dr. Shipley by request gave a very interesting talk on his experimental work on the calcification of rachitic bone *in vitro* in different kinds of salt solution. Dr. Campbell showed an interesting and very ingenuous method of studying the lymphatic system in bones. He also showed some beautiful specimens.

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**The Faculty of Medicine of Vienna University** arranges courses of lectures in German each year. These are planned for the purpose of enabling doctors to continue their study and give them an opportunity of training in special branches. The syllabus of these lectures and also information with reference to the courses may be obtained from the "Kursbureau" of the Vienna Faculty of Medicine, Schlosselgasse 32, Vienna VIII.

Four times a year, in February, June, September and November, Internationale Fortbildungskurse (International finishing courses), lasting two weeks each, are arranged, dealing with progress in the different special branches of medicine. A syllabus of these courses may be obtained from the Secretary, Dr. Kronfeld, Porzellangasse 22, Vienna IX, or at the "Kursbureau" at the above address.

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A meeting of the **Boston Orthopaedic Club** was held in Sprague Hall of the Boston Medical Library, on Monday evening, November 14, 1927. The speaker of the evening was Dr. H. Winnett Orr of Lincoln, Nebraska. His subject was "Listerism—properly and improperly applied in the treatment of infections of bones and joints."

Dr. Orr reviewed the history of the treatment as described by Lister, discussed the reasons for failure in the treatment of chronic and acute infections of bones and joints, and advocated the following technique in the treatment:

Complete saucerization of all wounds.
Painting with ten per cent. iodin followed by ninety-five per cent. alcohol.
Packing the wound wide open with sterile vaselin gauze pack.

He then emphasized the necessity of absolute fixation (plaster cast), and where necessary the use of traction. He said that the wound should be left alone and not dressed at all, unless there is a rise in temperature or other signs of acute sepsis, that a dressing should be done at the end of two or three weeks, this dressing to be repeated in about the same length of time. He discussed the reasons for the failure of the Carrel-Dakin method, and emphasized the fact that a wound treated in that way is constantly reinfected, the same being true of any type of wet dressing.

A very comprehensive series of lantern slides was shown.

The paper was discussed by Drs. Porter, Stone, Ridlon, Simmons, Cotton, Osgood and Wilson. The gist of the discussion was that while Dr. Orr's methods in his hands and in the hands of men who appreciate the situation were apparently bringing excellent results, yet there was a danger in spreading broadcast the idea that leaving wounds alone was the best method of treatment.

The Club was particularly delighted to have with them Dr. Ridlon whose discussion was thoroughly enjoyed by all, and who is always a welcome guest.

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**The Fifth International Medical Congress for Industrial Accidents and Occupational Diseases** is to be held in Budapest during September 1928. The Executive Committee consists of the following: President, Dr. Tibor de Verebely, Professor at the University; Vice-President, Dr. William de Friedrich, Professor at the University; Secretary-General, Privatdozent Dr. George Gortvay, Section Chief.

The National Committee for the United States has been created, of which Dr. Emery R. Hayhurst, Columbus, is Chairman.

Addresses already scheduled by various prominent Europeans include the following: Professor J. Liniger, Frankfurt; Dr. F. Zollinger, Aarau; Professor K. B. Lehman, Wurzburg; Sir Thomas Oliver, London; Professor J. G. Sleeswijk, Delft; Professor Jutten, Munster; Professor Koelsch, Munchen; Professor Julius van der Hoeve, Leiden; Professor Dr. Stephan Jellinek, Vienna. Also lectures are scheduled to date by the following: Professor Salvatore Diez, Rome; Dr. C. Poenaru Caplescu and Dr. Presbeanu, Bukarest; Professor Theodor Sommerfeld, Berlin; Dr. Lorenz Bohler, Vienna; Professor Dr. Quensel, Leipzig; Professor Dr. C. Marcus, Breslau; Professor Dr. Molineus, Dusseldorf; and Sanitatsrat Dr. Alfred Peyser, Berdin-Charlottenburg.

Addresses and lectures are wanted from American physicians, dentists and other specialists in the field. Such are requested to get in touch with the Chairman for the National Committee for the United States, Dr. Emery R. Hayhurst, Hamilton Hall, Ohio State University, Columbus, Ohio. General invitation is also extended to attend the Congress which will be arranged so as to coordinate with the "Deutscher Naturforscher Tag" to be held in Hamburg, and the "Orthopadenkongress" to be held at Prague during the month of September 1928.

**United States Civil Service Commission Announcements.** The United States Civil Service Commission has announced that hospitals of the United States Public Health Service and the Veterans' Bureau throughout the country are in urgent need of laboratorians in bacteriology and roentgenology and that applications for the positions will be rated as received until January 7, 1928. For full information and application blanks (Form 2374) apply, stating the title of the examination desired, to the secretary of the local board of United States civil service examiners at any first class post office, or to the United States civil service district secretary at Boston, Mass., New York, N. Y., Philadelphia, Pa., Washington, D. C., Atlanta, Ga., Cincinnati, Ohio, Chicago, Ill., St. Louis, Mo., New Orleans, La., Seattle, Wash., San Francisco, Calif., or Denver, Colo.

The United States Civil Service Commission announces open competitive examinations for Associate Toxicologists. Applications for associate toxicologists must be on file with the Secretary of the Fourth United States Civil Service District, Washington, D.C., not later than January 10, 1928. Full information may be obtained from the United States Civil Service Commission at Washington, D. C., or the Secretary of the United States civil service board of examiners at the post office or custom house in any city.

The United States Civil Service Commission announces open competitive examinations for Technical Assistant in Sanitary Engineering. Applications for technical assistant in sanitary engineering must be on file with the Civil Service Commission at Washington, D. C., not later than January 14. The date for assembling of competitors will be stated on their admission cards, and will be about ten days after the close of receipt of applications. Full information may be obtained from the United States Civil Service Commission at Washington, D. C., or the secretary of the United States civil service board of examiners at the post office or custom house in any city.

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**The American Board of Otolaryngology.** An examination was held in Detroit on September 12, during the session of the American Academy of Ophthalmology and Otolaryngology. One hundred and two applicants appeared for examination, with .107% failures.

An examination was held in Memphis on November 14, preceding the session of the Southern Medical Association, with .127% failures.

In the course of the past year, three hundred and sixty nine applicants have been examined.

In 1928, examinations will be held in Minneapolis, on June 11, at the session of the American Medical Association, and in St. Louis, on October 15, during the meeting of the American Academy of Ophthalmology and Otolaryngology.

Prospective applicants for certificates should address the Secretary, Dr. W. P. Wherry, 1500 Medical Arts Bldg., Omaha, for proper application blanks.

Dr. H. P. Mosher,
President.

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The Editorial Office of the *Journal* is in need of a bound set of the *Journal*. At the present time not even a complete file of unbound volumes is available. Some volumes are incomplete, others are lacking entirely. The Editorial Office should have a complete bound set of the volumes of the *Journal*. If any member of the Association, or any reader knows of some good friend of the *Journal* who possesses such a set, and would like to place it where it will be of real service, he is requested to correspond with the *Editor*.

At the meeting of the Executive Committee of the **British Orthopædic Association** held on July 12, 1927, the following officers were nominated for the year 1928–1929.

Emeritus President, Sir Robert Jones, Bart., K.B.E.
President, E. W. Hey Groves.
Vice-President, R. C. Elmslie, O.B.E.
Honorary Treasurer, W. R. Bristow.
Honorary Secretary, A. S. B. Bankart.
Editorial Secretary, H. Platt.

Other members of the Executive Committee:

Naughton Dunn.
S. T. Irwin.
St. J. G. D. Buxton.

The following candidates were elected Honorary Members:

E. Muirhead Little, Esq., L.R.C.P., M.R.C.S., 32 Ashley Gardens, Westminster, London, S.W.I.
John Ridlon, Esq., 7 W. Madison Street, Chicago, Illinois.

The following were elected Full Members:

N. D. Royle, Esq., M.D., Ch.M., Craignish, Macquarie St., Sydney, New South Wales.
R. Watson Jones, Esq., B.Sc., M.B., 31 Rodney Street, Liverpool.

The following were elected Associate Members:

Gordon Oxburgh Tippett, Esq., M.R.C.S., 4 Russell Court, Kensington, London, W. 14.
L. H. F. Walton, Esq., M.R.C.S., Pembridge House, 10 Strawberry Hill Road, Twickenham, Middlesex.

At the meeting of the Executive Committee on November 10, the following were elected Full Members:

C. Lambrinudi, 62, Upper Berkely Street, London, W. 1.
E. S. Brentnall, 2, St. Peter's Square, Manchester.

The following were elected Associate Members:

Dr. E. Henrietta Jebens, 16 Nottingham Place, London, W. 1.
J. S. Levis, M.C., 20 Gay Street, Bath.

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## BRITISH ORTHOPAEDIC ASSOCIATION

### Proceedings of the General Meeting, held in Bristol, October 21 and 22, 1927.

*First Day: October 21.*

Discussion on "The Treatment of Congenital Dislocation of the Hip". Opened by Mr. E. W. Hey Groves.

Mr. Hey Groves said: He would first refer to a few points of anatomy. The head of the femur normally was mid-way between the sacro-iliac joint and the anterior superior spine, as viewed from the front, and directly underneath the lumbar vertebrae, as viewed from the side. The treatment of congenital dislocation aimed at the restoration of the head of the femur to this normal anatomical position.

He exhibited a specimen of a congenital dislocation of the hip taken from a new-born babe; and pointed out the extreme anteversion of the neck, and also that the capsule was lax and thin; the thickening of the capsule which occurred later was secondary to weight-bearing on the limb.

He did not intend to discuss the bloodless method of reduction. It gave often a perfect functional result although anatomically the reduced hip was rarely quite normal; the acetabular roof was often fluffy and ill defined, and the head of the femur frequently showed the changes associated with pseudocoxalgia. But the method of closed reduction sometimes failed and open operation was sometimes preferable.

He divided cases into three groups: (1) Those where reduction was easy and gave a good result; he agreed that operation was unnecessary on these cases. (2) Those where reduction was not possible; operation was then certainly indicated. (3) Those where reduction was uncertain; the hip did not go in with a definite click, and the subsequent radiogram did not show the head of the femur at the correct level. There would be no unanimous opinion on these doubtful cases, but in his opinion they should be operated upon.

At operation he had noticed two facts: (1) the hour-glass constriction of the capsule. He thought that when closed reduction was attempted on these cases, the capsule was either ruptured, or more probably that true reduction did not occur, the head being forced into the acetabulum pushing in front of it a fold of capsule. (2) He had noticed that the acetabulum was shallow,—more like a saucer than a cup. Reduction in these cases, although easy, was not secure.

These two factors—the constriction of the capsule and the shallowness of the socket—were the problems that confronted the surgeon.

He would describe the various methods he had used in chronological order.

When the constriction of the capsule was the bar to reduction and the acetabulum was of fair depth, he incised the capsule parallel to the neck, reduced the dislocation, and sewed up the capsule transversely (capsulorrhaphy).

To deepen the socket he had gouged out a new acetabulum, but this resulted in a hip, which although painless and stable, gave only ten degrees of movement. And one wondered whether the patient would not have been better without the operation. The stiffness and deformity resulting from this method led him to try making a new roof to the acetabulum in preference to deepening the socket. In his first cases he used a graft taken from the iliac crest which he pinned with ivory nails to the acetabular rim; the resulting new rim was, in the radiogram, small and insufficient. He therefore used a more massive graft made of ivory. The third method, the best he had tried, was turning down two thick converging flaps from the dorsum ilii, consisting of bone as well as periosteum. These are held down by driving in two ivory pegs at their bases. The results on the whole were gratifying, giving mobile hips; but stability was not secured, because in almost every case the new acetabular roof was made too high. It seemed difficult or even impossible to make the new roof low enough. He had, therefore, reverted to his original method of deepening the acetabulum and in order to avoid a stiff joint had lined the newly formed acetabulum with capsule. At the operation the capsule was dissected off the acetabular rim and sewn over the head of the femur with a purse-string suture, and the suture was then passed through a hole made in the centre of the floor of the acetabulum and tied over the brim of the pelvis; thus anchoring the head of the femur, enveloped in capsule, in the newly dug out acetabulum. The result of this operation was a stable and mobile hip, but what the ultimate results would be in years to come he did not know.

In the adult cases he did not think reduction was justifiable; the manipulation, even after long preliminary traction, was severe and productive of great shock, and a stiff hip joint was the outcome. In the late unilateral case he was in favor of doing Lorenz's bifurcation operation. The Lorenz operation did three things: it tilted the pelvis down, it gave a wide area of contact between the femoral shaft and the pelvis, and it transmitted the weight of the body more directly to the femur. In the late bilateral case, he did a Lorenz bifurcation osteotomy on one side, and on the other he shortened the femur by removing two inches of bone below the small trochanter; this enabled the head of the femur to be brought down opposite the acetabulum, and fixation was secured by an intramedullary peg driven into the shaft from the trochanter above.

Mr. R. C. Elmslie said: There was no need to discuss ordinary closed reduction; the method gave good functional results.

In the matter of open operations surgeons were groping in the dark. What were the best methods? Mr. Hey Groves had tried many and did not seem yet quite satisfied. What were the results—not the immediate results but the late results after, say, twenty

years? He thought open operations on congenital dislocations of the hip should be regarded as scientific experiments, the results of which should be carefully followed up and recorded. One patient, on whom Kocher had operated twenty years previously (He had made a new acetabulum, at the proper level.) had lately come under his observation. The woman had remained comfortable for many years but now had such a painful deformed hip that arthrodesis was unavoidable.

He would add a fourth class to Hey Groves's classification, comprising those cases which, after easy reduction, redislocated. In these he considered open operation—the reformation of a new roof to the acetabulum—was valuable. On the occasions he had done the operation he had not gotten the new shelf low enough.

Many years ago he saw Mr. Jackson Clarke operate on such a patient; he exposed the upper rim of the acetabulum and with a sharp rougine pushed the periosteum down to and over the edge of the acetabular rim. This hip remained in. He thought this operation was worthy of further trial because the capsule was not opened.

He had found it difficult to obtain an adequate exposure and after trying both the anterior and the posterior approach he was still dissatisfied.

Lorenz's operation, in his opinion, was particularly suited to bilateral cases; both femora could be divided at the same operation.

Many patients with old unreduced congenital dislocations had painless and mobile hip joints; and this fact must be borne in mind in assessing the value of open operations.

Mr. H. A. T. Fairbank, (the President) said: His practice was to make a new lip to the acetabulum in a child of reasonable age (between four and five), when, either (1) after easy reduction the head had redislocated, or (2) there was a marginal displacement of the head; this could be detected by the x-ray, and in these children be operated at once, because closed reduction always failed.

He agreed with Mr. Hey Groves that it was difficult to make the new lip at the correct level.

He used the Smith-Petersen approach, and found it satisfactory.

His results could be tabulated as follows:

| | | |
|---|---|---|
| Number of open operations (excluding those for pain in adolescents and adults) | | 44 |
| *Open reduction* | | 10 |
| Failed to reduce | 3 | |
| Cured | 3 | |
| *Open reduction, plus upper lip operation* | | 3 |
| Died from shock | 1 | |
| Too recent for result | 2 | |
| *Upper lip operation, plus opening of joint to verify satisfactory reduction* | | 4 |
| Cured | 2 | |
| Probably cured | 1 | |
| *Upper lip operation* | | |
| Without bone graft (i.e. periosteal flap only) | | 3 |
| With bone graft but no pegs | | 3 |
| Cured | 1 | |
| With graft and living bone pegs | | 2 |
| Cured | 2 | |
| With graft and beef bone pegs | | 19 |
| Cured | 9 | |
| Failed | 4 | |

Of the total number of operations in which a definite attempt was made to fashion an upper lip to the acetabulum the late results are known in twenty-three (excluding the case that died soon after operation). Of these, fourteen are cured and one other is almost certainly a cure. By "cure" he meant the operation had resulted in a definite upper lip

to the acetabulum sufficient to prevent subluxation with certainty, the hip being either in the correct position or only slightly above this level. He did not mean the functional result which depends on many factors over which the actual operation has no influence.

It must be remembered that attempts to fashion an upper lip have been made only in older children and in those in which other methods have failed, i.e., in cases in which perfection from every point of view was not to be expected except in a minority of the cases.

Mr. H. Platt said: Reports from the American Continent suggested that the results of open operation, done during the age period when closed reduction had hitherto been the usual procedure, were better than those from manipulative reduction. Closed reduction always gave a certain number of failures,—the hip came out again (redislocated) or remained too high (subluxated). Experience at operation had convinced him that the isthmus of the capsule was an important factor in preventing reduction by the closed method. He himself was trying out the open method; he was not advocating open reduction as the method of choice on every patient; he did not know whether it was or not, he was simply trying to find out.

The reason why it was difficult to make the new acetabular rim at the correct level was the presence of an intermediate acetabulum above the true primitive acetabulum; as Calot had pointed out, there were three sockets in a congenital dislocation one above the other.

The Smith-Petersen approach was, in his opinion, satisfactory, but frequent operating was necessary before the surgeon became deft at the operation, and he considered the operation one of the most difficult in surgery. He had found great assistance in dissecting all muscles off the capsule before opening the joint.

Mr. Hey Groves, in reply, said: He congratulated Mr. Fairbank on his beautiful results. His radiograms proved that it was possible to make a good new acetabular roof and at the correct level. He used the Smith-Petersen approach which gave a complete exposure. He had never done Lorenz's operation on both sides in a bilateral congenital dislocation; he thought it would leave the legs widely abducted and render walking difficult. He did not advocate open operation on every patient with a congenital dislocation of the hip joint. If closed reduction was easy, and complete, and permanent, he did not operate. If reduction was difficult, or did not seem complete, or if the hip redislocated, he advised open operation.

Mr. George Perkins read a short paper on "The Early Diagnosis of Congenital Dislocation of the Hip".

Mr. Perkins pointed out that the diagnosis could be made by inspection, having regard to three signs,—the female silhouette, the shortening of the thigh, and the dip of the shoulder when walking.

He also drew attention to the value of two lines— one, horizontal at the level of the innermost part of the cartilage in Y, and the other, vertical drawn downwards from the anterior inferior spine—in detecting on the radiogram whether the head of the femur was in its correct position.

Dr. Maud Forrester-Brown read a short paper on "School-children's Posture and Remedial Classes".

Miss Forrester-Brown exhibited a number of slides showing the value of remedial classes for improving the posture of school children. She had found that only forty per cent. of school children could be classed as having a "Class A" posture. The County authorities of Somerset had been convinced of this fact, and were endeavoring to overcome it by appointing a woman especially to deal with school gymnastics. The vast number of children with bad posture made it impossible to treat them in special clinics. Good posture could, and should be taught by the ordinary school teachers.

Mr. Paul Bernard Roth read a short paper on "Fractures of the Tibial Spine".

He reported four cases, on which he had operated within a few days of the injury. He found in every case that the bone fragment could be replaced, but only after division of the anterior attachment of the external semilunar cartilage. When this had been

done extension of the joint reduced the displacement and no suture was necessary to retain it in position. All four patients recovered completely. After the operation the knee was held extended in a plaster-of-Paris casing for a month. The condition could easily be distinguished from an injury to the semilunar cartilage; because the trauma was more severe, the joint filled immediately with fluid (hemorrhage), the knee was held semiflexed and immobile, and pain was severe.

In the afternoon Mr. Hey Groves operated at the Bristol General Hospital:

1. For congenital dislocation of the hip.
   The acetabulum was deepened by gouging out its floor, and the raw area covered by capsule by dissecting off the capsule from the acetabular rim and sewing it with a purse-string suture over the head of the femur.
2. For ununited fracture of the neck of the femur.
   The detached capital fragment was fixed by a bone peg driven in from above, through the head of the femur across the fractured surfaces into the neck.

Mr. Hey Groves then showed a number of patients on whom he had done various operations for congenital dislocation of the hip joint.

*Second Day: October 22.*

Cases were shown at the Bristol Royal Infirmary in the morning, by:

Mr. Hubert Chitty:

1. Lupus and generalized osteitis deformans in the same patient.
2. Two children with ununited simple fractures of the tibia and fibula.
3. Congenital scoliosis.
4. A boy with interstitial nephritis, with renal dwarfism and deformities.
5. Transplantation of the peronei in a baby for congenital valgus.
6. A girl with osteogenesis imperfecta, with bending of the long bones, who had had, up to puberty, many fractures.
7. Transplantation of the tibialis anticus to the outer side of the foot for congenital talipes equinovarus.
8. A girl with absence of the ulna, and in whom the radius and the humerus were fused to form one bone.

Mr. C. F. Walters:

1. A man with a fracture dislocation of the shoulder, which had occurred during a fit.

Mr. A. Rendle Short:

Six patients, all in perfect health and working, after Albee's bone grafts on the spine for tuberculosis.

Mr. A. W. Adams:

1. A complete pretibial dislocation of the astragalus, complicating a Pott's fracture, which had been reduced without open operation.
2. Fracture of the internal condyle of the femur and fracture of the patella in the same knee.
3. Complete diaphysectomy for osteomyelitis.
4. Congenital absence of the radius with club hand, treated by prolonged splintage.
5. Cases of congenital talipes equinovarus treated by repeated wrenchings and plasters from birth.
6. A patient with congenital contracture of many joints, treated by prolonged splintage.

Mr. W. A. Jackman:

1. A patient with osteitis deformans first noticed at the age of seventy-four.
2. A girl with three needles in the tissues around the hip joint with signs mimicking tuberculosis of the joint. Needles probably self inserted.

A visit was paid to the Pump Rooms at Bath in the morning before lunch.

In the afternoon The Bath Somerset and Wilts Central Children's Orthopaedic Hospital, at Combe Park, Bath, was visited. A demonstration was given by Mr. W.

G. Mumford and Dr. Maud Forrester-Brown showing the end results of tendon transplantation and bone fusion operations for paralytic and congenital deformities of the feet; also of Hibb's extra-articular arthrodesis for tuberculosis of the hip joint.

## CLINICAL MEETING
## AMERICAN ORTHOPAEDIC ASSOCIATION

A clinical meeting was held at the House of the San Francisco County Medical Society, San Francisco, Calif., Saturday, June 18, 1927, with the President, Dr. James T. Watkins, in the chair.

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### DEUTSCHLANDER'S DISEASE

DR. GEORGE MCCHESNEY: In 1922–23 a German surgeon, named Deutschlander, in Hamburg, described a disease of the second metatarsal bone which came on without known trauma, did not yield to any known form of treatment and seemed to recover or disappear spontaneously in the course of two or three years. There is no literature that I have been able to find on this subject in English. The Zeitschrift für Chirurgie has a few articles and Deutschlander's articles were translated for me through the courtesy of Dr. Dresel.

The patient to be presented gave a history that he had been perfectly healthy up to the time of his injury. He had some minor accidents which have no bearing on the present complaint. In July 1925, two heavy beams from a truck fell upon his right foot. At the same time he was forced backward with the foot bent down in marked plantar flexion. The x-ray taken on the day of injury showed same findings as those taken by me a year later. He was given routine physiotherapy treatment with no benefit. He had an interference with the circulation, though not a typical Raynaud's disease. The skin was cool and bluish. In April 1926 an operation was done, not by me, to improve the circulation; in other words, stripping the outer coat of the femoral artery to remove the vasomotor inhibition. The local surgeon who did this operation thought at first he had some improvement but said later in his reports that he did not think there was any particular change. The patient was brought before the Industrial Commission and then sent to me.

I found this curious appearance of the second metatarsal bone. The bone was thickened. There were no areas of rarefaction, such as would be suggested by Osgood-Schlatter's disease, or by the various forms of rarefying osteititis such as occur in Kohler's disease or Legg's disease of the hip. He had had this severe wrench. An x-ray was taken the day I saw him and this same enlargement found. A second picture was taken a month or two ago and here again you see exactly the same symmetrical enlargement of the sheath of the second metatarsal, which suggests a mono-articular form of Paget's disease, except for the fact that in the x-ray picture there are no areas of rarefaction.

Clinically the man has a great deal of pain. He has to walk on the outer border of the foot. He has been treated by padding behind the metatarsal heads and finds that padding behind the fourth and fifth most beneficial. He has no pain in the big toe. There is the usual evidence of a slightly impaired circulation. The foot is slightly thickened. I have treated him with physiotherapy, arch supports, metatarsal pads and, of course, with antiluetic treatment with no relief of the pain. The Wassermann is negative. He is a total invalid. Ruggles, our x-ray man of wide experience, recalls seeing a case similar to this two or three years ago. He was a patient of Dr. Baldwin. No one knew what the condition was.

#### DISCUSSION

DR. ARTHUR STEINDLER, Iowa City, Ia.: I believe that is pathologically a corollary to what we call March foot. I think it is a rare condition.

Dr. Robert B. Osgood, Boston, Mass.: Possibly it is a type of the sclerosing osteitis of Garre.

Dr. Fred H. Albee, New York, N. Y.: I have operated on two cases with very similar x-ray pathology as was found here. I took out a piece of the bone and had it examined and found a chronic inflammatory process. In these two diseases the x-ray is very similar. The medullary cavity may be encroached upon but not entirely obliterated.

Dr. Leo Mayer, New York, N. Y.: I would like to confirm what Dr. Albee said. I have had two cases, not in the metatarsal but in other joints, corresponding, as Dr. Osgood has just suggested, to the picture of Garre of sclerosing osteomyelitis. The patients were much relieved by the removal of the cortex down to the medullary cavity.

Dr. F. J. Gaenslen, Milwaukee, Wis.: It seems to me the conditions are rather different. The x-rays here show a thickening of the shaft of the bone. It is laid down subperiosteally and you can distinguish very readily between the shaft and the new bone. In Garre's ossification the condition is different. There is uniform thickening of the shaft without any laying down of the bone. It seems to me it is a thickening of the shaft itself.

Dr. Albee: I believe it is only a question of duration until you get a separation from the cortex.

## RECONSTRUCTION OF THE HIP

Dr. Lionel D. Prince: The first case which I wish to report is one in which a reconstruction of the hip joint has been done for an old ununited fracture of the neck of the femur.

Mr. J. R., aged fifty-three. On September 24, 1924, while attempting to get out of the way of a taxicab, fell, sustaining a fracture of the neck of the right femur and fractures of the tibia and fibula. He was placed under the care of a physician who reduced and immobilized the fractured tibia and fibula, but for some reason the fracture of the neck of the femur was entirely overlooked. He was seen by me in July 1925, at which time he complained of pain in the region of the right hip and was unable to walk without the aid of crutches. X-rays taken at that time showed a fracture of the neck of the femur with practically complete absorption and upward displacement of the trochanter, the head likewise showed some degree of absorption. A reconstruction operation after the manner described by Whitman was advised at that time, but, owing to the extremely poor physical condition of the patient, he was deemed constitutionally unfit for the operation. His blood Wassermann was four plus. He was put under rigorous antiluetic treatment. In January 1926 a reconstruction operation was performed. The operation was done largely under spinal anaesthesia, but, owing to the fact that the patient experienced some pain during the removal of the head of the femur, a small amount of gas was administered. A spica cast was allowed to remain on for four weeks and the patient was then permitted to walk without the aid of crutches. In April the man was permitted to return to his duties, as his employment consisted largely of desk work, and he was able to do all his work quite satisfactorily. In September he discarded his crutches and used a cane only. At the present time he gets about without any cane, though he carries one when on the street. The patient experienced very little pain in the hip joint following removal of the cast and his convalescence was practically without painful symptoms. At the present time the hip shows practically normal motion with the exception of some moderate limitation to internal rotation. The patient has never received any physiotherapy treatment. He has about five-eighths of an inch shortening of the leg but this has been corrected by raising the sole of the shoe.

I desire to show the x-rays on this case. The first x-ray, you will perceive, was taken when the patient was first seen and it shows complete absorption of the neck with the characteristic upward displacement of the trochanter. The second x-ray was taken following the removal of the postoperative cast, and shows the transplanted trochanter in satisfactory position. The third x-ray is extremely interesting in that it shows the

enormous hypertrophy which the transplanted trochanter has undergone, probably as result of functional use. This hypertrophy of the trochanter has unquestionably increased the leverage action and function of the trochanteric muscles which explains the excellent functional use of the hip which the patient now has.

## COMPLETE TRAUMATIC DISLOCATION OF THE CLAVICLE AT THE ACROMIOCLAVICULAR JOINT, RIGHT SIDE

DR. LIONEL D. PRINCE: The next case which I desire to show is that of a complete traumatic dislocation of the clavicle at the acromioclavicular joint with rupture of the ligaments.

Mr. M., age thirty-one, was injured on November 24, 1926, in an automobile collision. He states that he was thrown violently against the side of the car which is the mechanism supposed to produce clavicular dislocations of this type. When first seen, the shoulder region presented the characteristic deformity, the clavicle riding upward and the acromial end appearing as a prominence at the base of the neck. The scapula was tilted outward to such a degree as to permit considerable dropping of the shoulder joint. The man was totally incapacitated as far as the use of his right arm was concerned and experienced considerable pain. An attempt was made to reduce the dislocation by manipulation but the reduction was incomplete so that an open operation was deemed advisable. At the time of the operation the coracoclavicular and coraco-acromial ligaments were found to have been completely evulsed at their attachments to the clavicle and acromion. The clavicle was placed in its normal relationship to the acromion and the capsule sutured with interrupted chromic catgut. In addition a heavy chromic gut was passed through the hole drilled through the acromion process and the clavicle, thereby insuring more firm fixation. The coracoclavicular and acromioclavicular ligaments were identified and sutured in their normal anatomical positions by means of holes drilled through the clavicle and acromion process. The arm was bandaged to the side by means of a plaster-of-Paris bandage and was kept immobilized for a period of about four weeks. Following removal of the fixation bandage, the patient was given light exercises and a few physiotherapy treatments, extending over a period of about two weeks, were administered. In two months from the date of operation the patient had normal motion in the shoulder joint, and at the end of three months he was entirely free from any disability, motion in the shoulder joint being normal and the pain completely absent. The patient stated that after three months he was able to play his usual golf game without experiencing any pain or fatigue in the shoulder.

The first x-ray does not show the marked displacement of the clavicle as the picture was taken with the patient in the recumbent position. The marked deformity and displacement was more evident when the patient was standing. The second x-ray I am exhibiting was taken a few days ago, and shows the clavicle in its normal relationship to the acromion. An unusual condition brought out by this x-ray is that the coraco-acromial and coracoclavicular ligaments have undergone a remarkable degree of ossification, so that these ligaments are clearly visualized. They are likewise shown in their true anatomical relation to the surrounding bony structure. I believe that the ossification of the ligaments has probably contributed to the stability of the acromioclavicular joint and is partially responsible for the excellent result obtained in this case.

DR. LIONEL D. PRINCE: I desire to call your attention to a bed to which is attached an adjustable Bradford frame. The apparatus is a modification of one used by Dr. Campbell and Dr. Speed in their clinic in Memphis. This one, however, is portable and may be attached to any bed. It may be lengthened or widened and there is a mechanism to elevate or lower the frame. In most fracture-beds the mattress drops and in this apparatus the frame is elevated above the mattress by detaching the lower or upper ends of the frame; each end may be elevated or lowered independently of the

other end, which is a distinct advantage where one wishes to regulate the position of the patient in bed, as for instance in shock cases. The portability of this appliance gives it many advantages and its adaptability to the requirements of the patient greatly simplifies the problems of nursing.

## FUSION OPERATION FOR FRACTURED SPINE

Dr. E. W. Cleary: The case which I wish to present is one of fracture of the first lumbar vertebra, a compression fracture treated by a fusion operation of the spine according to a special technique which I have used almost as a routine for several years.

In 1921 I saw a young man who had fallen fifty-three feet and had, as a result, a very severe compression fracture of the twelfth dorsal, with a complete paralysis of the left lower extremity and of all the muscles below the knee on the right. I called in consultation a neurosurgeon and it was decided that we should operate. My problem was how to save enough bone so as to insure a good fusion of the spine after the neurosurgeon had gotten through taking away as much of the bone as he wanted. I concluded I would try to get a lot of bone out of the way before the neurosurgeon did his laminectomy and then use that in connection with grafts from the tibia to make the fusion afterwards. That patient got on so well that I used the operation afterward in other cases.

One of my patients on whom I did a double graft fusion by this method had a second accident three and one-half months after operation. He went over a cliff in an automobile and broke his back again, fractured all his ribs and was fatally injured.

I secured the specimen of that fusion which I will pass around for inspection. This was a fusion of the first lumbar to the second lumbar and to the twelfth dorsal. When I do this type of operation now, I carry my grafts farther down than these show in the specimen. When I have failed in fusion operations, it has been the lower set of articulations which did not become solid. Hence I now take special care that the grafts extend well across these. The patient was wearing a Taylor back brace at the time he had the second accident and was practically free from pain without the brace.

Dr. Osgood called to my attention that one of my drawings was faulty. It does not show the exact method of cutting the grafts from the tibia. The grafts are taken from the inner side of the tibia. First a rectangular area is marked out and before completely loosening this it is separated into two grafts, by sawing longitudinally in a plane oblique to the surface of the bone. When the grafts are removed they are in cross section like very thick knife blades. When the grafts are placed in position in the back they lie in this position (indicating), back to back, in the center, the edges of the blades passing out across the articulating facets which have been split.

The patient I am going to demonstrate today was operated on two months ago tomorrow. He had a compression fracture of the first lumbar with an obliteration of the disk between the twelfth dorsal and first lumbar, with no evidence of an acquired fusion after two years. He had a great deal of pain in the back and was totally incapacitated for physical labor. He tells me today that he has been getting up on his feet in a Taylor back brace for two weeks. He has lost his old pain and the feeling of weakness in his back, but still has some pain laterally. He had a girdle of hyperaesthesia at the time of operation.

I think we should fuse severe compression fractures of the spine early and not wait to see if a fusion will take place without operation. We should treat the badly distorted vertebral joint by early arthrodesis just as we treat any other hopelessly distorted major weight-bearing joint by arthrodesis.

## OPERATIVE RESULT AFTER DOUBLE CONGENITAL DISLOCATION OF THE HIP WITH DOUBLE TALIPES EQUINUS VARUS

Dr. S. L. Haas: The cases I am to present are from the Clinic of the Shriners' Hospital. The first case is a double congenital dislocation of the hip with a marked

torsion and flexion deformity in the femur and tibia. Double congenital dislocation is very common. In this particular case the torsion in the femur on the right side was so extreme that the patella was back in the popliteal space. There was no dislocation of the patella which was in that position due to the extreme rotation. The child could flex the leg and twist it seemingly in a normal way. The extension of the knee was performed by the inner hamstrings and the quadriceps was playing only a minor part in that movement. The p tient had been under treatment for four years and numerous manipulations had been attempted. At one time the left hip had been successfully reduced but had redislocated. After coming to the hospital a closed reduction was at first performed successfully on the left but unsuccessfully on the right. The left promptly redislocated. Then an open reduction was performed, first on the left with a shelf operation. Later on, the child was sent home for a while and when brought back the right hip was reduced and a second shelf made on that side. The heads of the femora remained in place.

The next problem was to correct the torsion deformity of the right femur. An osteotomy was performed at the lower end of the femur and the lower fragment rotated inward. This brought the patella into its normal position. After bringing the patella in normal position, the foot became posteriorly rotated, so that it was necessary to perform another operation on the tibia in order to bring the foot around to a straight position. At present that is as far as we have gone with that child. The talipes equinus has been ignored. She can now walk although it is only two months since the last operation on the right femur, which still requires plaster support. There still exists a marked instability of the right knee which will require some plastic operation on the ligaments. Another interesting point is the marked range of motion that still exists after numerous attempts at reduction and the severe trauma. At the time of operation there were numerous adhesions and the acetabulum was filled with fibrous tissue. After all these insults she still has marked mobility, although there was every reason for restriction in motion.

## ARTHROPLASTY OF THE HIP

Dr. E. C. Bull: This patient had a history of suppurating osteitis with an acute respiratory infection at the age of eight months. The hip was aspirated twice but never drained. He began to walk at the age of nine months and the only thing noticed was the shortening. When he entered the hospital there was hypermobility of the hip. It was more free than the average dislocated hip. X-ray indicated a shallow acetabulum, though clinically there was no acetabulum present. There was no head or neck of the femur. The operation included two stages, first, the construction of acetabulum, so that the tissue about the anterior superior spine was removed and replaced, being planted under two flaps at the side to which we thought we could draw the trochanter. The edges of the transplanted piece of bone were split so that the tables separated, giving the appearance of a fracture of this bone. Subsequently through a lateral approach the muscular insertions were removed and inserted on a line with the fascia transplant.

The operation was done in April 1926 and in September the trochanter was placed in the newly formed acetabulum. He was in traction for two months after the first operation. Then he was in plaster after the second operation for seventeen months. The amount of movement was very surprising. He has little less than normal external rotation. Internal rotation is about normal. I have an idea that he is now at about the right age for an arthroplasty.

## EXCISION OF SACRALIZED FIFTH LUMBAR TRANSVERSE PROCESS

Dr. Howard Markel: My classmate and co-worker for years was Dr. Walter I. Baldwin. Two years ago he presented before this Association six cases of excision of the transverse process of the fifth lumbar vertebra for sciatic pain. I helped him with

several of those cases. He was very much interested in this work at that time. This past year I have had three upon which I have operated with relief of sciatic pain. The onset of pain in every one of these was acute pain coming on upon lifting or straining or a sudden twisting, indicating to me a tearing of the attachment of the sacralized transverse process; not a slow insidious onset but a very definite onset. I had hoped to have one of the patients here but she has been taken ill. I have pictures of the three cases which I will now show to you.

These three slides were shown to you by Dr. Baldwin and show the line of incision which is practically the same incision as is used for ramisection by Royle. The crest of the ilium is exposed and the attachments of the abdominal muscles are removed and that lets one right down onto the end of the transverse process.

The next slide shows the anatomy of the transverse process at that point. Farther on the other side you can see where the incision finds its way past the ilium and down into the transverse process. This shows the fifth transverse process pointing out from a rather deep hole. It is necessary to put the patient on a kidney table with an elevator and with a lateral bend in the body. The fifth lumbar nerve passes directly in front of this fifth transverse process. It can be easily kept out of the way by retraction. The advantage of this incision is that one can see where he is and thus avoid the nerves and prevent a foot drop which can happen very easily with a posterior incision if the nerve is injured. In this patient, in the original x-ray it was very easy to see the articulation of the sacrum with the fifth transverse process.

This second patient worked in a cooper shop, making heavy barrels for carrying oil and had to do a great deal of lifting. He had constant pain. In this x-ray you can see that the transverse process is gone. It was a big job to get it all out, as it was in such a deep cleft. I did not injure the nerve or artery.

This third patient two years ago leaned over to pick up something and suddenly felt a very severe pain down the leg which persisted until I saw her. This pain was aggravated by weight-bearing and was distributed to the front and inner side of the leg. Here you can see the transverse process has been excised. This patient was entirely relieved of the pain when she walked. About two months later she came back and said the pain was occurring where it was before. I could not understand why she was having pain. She came back later and said she had had a miscarriage. After that she had no more pain. There was an articular cartilage in the ends of each one of these processes that had articulated with the sacrum in each one of these cases. I believe the pain was a reflex pain. In each case the pain had come on suddenly. All the patients had lifted heavy weights. There was evidence of a joint in every one of these cases. They all had a cartilage at the end of the transverse process.

## RESTORATION OF FRACTURE OF THE NECK OF THE RADIUS WHERE THERE IS COMPLETE DISPLACEMENT OF THE HEAD FRAGMENT

Dr. Frank A. Lowe: As far as I know this procedure has never been published.

Case 1. X-ray of a female, eleven years old. Transverse fracture of radius. Head fragment displaced downward along side of neck portion. Operation 1922.

An open operation over the head of the radius. A reposition of fragments is obtained and held in position by a small reamer, the latter being sunk through the central portion of the articular surface of the head, into the shaft of the neck across the line of fracture.

A small piece of bone is sawed, with an Albee motor saw, from the anterior inner surface of the tibia. This bone is shaped into a peg similar in size and shape to an old-fashioned iron shingle nail. The reamer is gently removed and the bone peg placed, excess cut away. The peg is countersunk just even with the cartilaginous layer. The orbicular ligament is repaired and the incision closed with silk-worm gut sutures. This patient is an accomplished pianist and plays over the radio. She has full flexion and

extension and only very slight limitation of supination and pronation. X-ray taken in 1926 shows excellent anatomical reposition of fragments and no excess callus.

Case 2. Male, eleven years of age. X-ray 1925. Fracture of neck of radius with some communition of fragments. Head fragment markedly displaced.

Operation by bone peg. X-ray shows reposition of fragments excellent with peg *in situ*. Boy has complete flexion and extension of the elbow but is limited in pronation and supination.

In neither of the cases is there an apparent or actual shortening of the arm, the longest observation being a little over four years.

I believe this to be a far better procedure in children than removing the head of the radius.

## PLASTIC OPERATIONS ON HIPS

DR. JAMES T. WATKINS: I am disappointed in that my first case has failed to appear. It was a lady upon whom I did a capital decortication in 1913. I showed her to you in 1915 and again in 1923. She still has ninety degrees of flexion and thirty degrees of abduction.

My second case is this gentleman whom I have not seen for four years, he tells me. This is the man I spoke of last year, whom I had tried to send to Dr. Baer. He had limped for some seventeen years and his limp was gradually becoming more pronounced with added pain and loss of motion. I would direct your attention to the cystic appearance of the femoral head in the first picture, with hypertrophic excrescences about the acetabular margins and atrophy of the capital cartilage.

In my first case I employed a vertical incision below the anterior superior iliac spine. In this one I used the Smith-Petersen approach. In the next case which I shall show you I used the Olier cut. I do not see that it makes any material difference which approach you employ. It is possibly a little easier to work through either of the two last incisions.

In all three cases I trimmed the head down with a wood carver's tool, and smoothed it off with the Murphy hollow cutting hemisphere and a shoemaker's rasp. Theoretically the Murphy tool is ideal. Actually it is not as effective as the rasp. The point about the whole thing seems to be to get the head small enough and at the same time to take away as little of its superior surface as possible so as not to create much shortening. The patient tells me he has remained perfectly well ever since we discharged him and is able to carry his two large sample cases on the road.

This next case is curious. I will show you the original x-ray and the wet one made this morning, six months after operation. The patient is now thirty-four. Following a fall when he was seventeen, he had constant trouble with his left hip with ever diminishing motion and increasing pain.

He first consulted Dr. Stoddard, then Dr. Markel, then Dr. Prince, then someone else and finally myself. I found no abduction, no adduction, no rotation, and only a suggestion of active flexion. The limb was in thirty degrees flexion and slight adduction. The x-ray showed atrophy of the cartilage of the head and an extensive collar of new bone just distal to the head. The acetabulum appeared undisturbed.

Ultimately he was operated upon by Dr. Stoddard and myself. We used the Olier incision. First the collar of bone was removed but motion was still impeded, so I dislocated the head and trimmed it down in the manner described. It was exceedingly dense. It was then replaced in the socket. We at once had ninety degrees flexion and good abduction.

At present the man has 180 degrees of extension and walks without a limp. He has about forty degrees of flexion, further flexion being apparently limited by adhesions which are sensitive to forced motions. Adduction is present and also abduction, but the latter is restricted about fifty per cent. Motion should be improved by use.

# Current Literature

ATLAS DE RADIOGRAPHIE DU SYSTÈME OSSEUX NORMAL. By G. Haret, A. Dariaux and Jean Quénu, compiled with the collaboration of H. P. Châtellier. Preface by Professor Pierre Duval, 132 pages, with 246 figures and diagrams. Paris, Masson et Cie, 1927, 160 francs.

This is one of the few works on radiology which has for its object the study of the normal skeleton. The authors in their text insist rightly on the importance of emphasizing the normal structure with the pathological lesions. They have employed a somewhat new method, that of accompanying each radiogram with a second of the same view, on which is marked, with sharp outlines, various contours and points to be detected and observed. These are shown in detail by the superposition of this drawing on the original radiogram. The views taken for study in this book have either been those of the cadaver, with all the soft parts intact, or else on the living, so that the radiograms are shown under the same conditions which must be used by the surgeon in his clinical problems.

The authors call attention to the fact that beside the diagnostic and therapeutic rôles of the x-ray, it should be remembered that the radiogram can be considered a valuable document, which is an aid in the classification and study of pathology of bone, also an aid in giving a visual image of the description, and particularly as a means of record when proof is needed in questionable or disputed cases. In the text there are also given directions in regard to interpretation of x-ray, for those who are not particularly skilled in the reading of the evidence of the radiograms, giving explanation of mechanical conditions which it is necessary to bear in mind both in taking and in the interpretation of radiograms.

They emphasize the need of the student being familiar with the radiograms of the normal, and the value of studying anatomy with the radiograms. The radiograms in this book have been taken with a great deal of care, and with each diagram is given the information necessary to interpret many of the details and also to estimate the normal size of the part, the distance of the plate from the tube and the proportion in which the radiogram must be reduced to correspond with the normal size.

The book is divided into three portions, one of the adult skeleton, second of the foetus *in utero*, and the new-born, and third, of different periods of growth from time of birth to the time of ossification of the epiphyses, demonstrating the peculiarities found at the different periods. The radiograms are usually taken with the parts in different positions and include with each one its diagram and outline to accompany the original photograph. In this way, the student or physician is enabled to study the normal, not only from the point of view of different angles, but also in different stages of growth. The book will be found unusually valuable for those who wish to make a preliminary study of normal bone as shown by the x-ray. There is in preparation another volume which will be devoted to the pathology of bone, and its appearance must be looked forward to with a great deal of interest.

BONE SARCOMA. The Primary Malignant Tumors of Bone and the Giant-Cell Tumor. By Anatole Kolodny. The Surgical Publishing Company of Chicago, 1927.

The writer has made an intensive study of the material originally collected by Codman for the Registry of Bone Sarcoma and later taken over by the American College of Surgeons. While the original Registry Committee classified all bone conditions under

eight headings, Kolodny groups malignant bone tumors into the (1) osteogenic sarcomata, (2) Ewing's sarcomata, (3) myelomata, (4) the unclassified sarcomata.

Kolodny doubts the wisdom of classification into periosteal, medullary and subperiosteal types as they cannot be determined clinically or accurately even by x-ray. He believes that the prognosis is no different and that the different types are but various stages in the same process. Cases of supposed "sclerosing" osteogenic sarcoma which were studied showed no tumors where "sclerosis" prevailed throughout the tumor. The "telangiectatic" type is an extreme condition of vascularity and may be the same condition as the malignant angioma. He suggests that "extraperiosteal" sarcoma be substituted for periosteal when referring to the fibrosarcoma arising from the outer layer of the periosteum.

An osteogenic sarcoma is a tumor derived from cells which, if and when fully differentiated, would have become osteoblasts, cells capable of producing bone. It is not necessarily true that they do produce bone. The differentiation may stop at any stage, and we may find in the same tumor spindle cells without definite arrangement, myxomatous cells, atypical cartilage or bone. Certain types of osteogenic tumors growing rapidly may destroy bone faster than new bone is laid down.

The main characteristics of osteogenic sarcoma as described are as follows. The tumor is most commonly found in the metaphyses of the long bones of adolescents. It extends along the medulla and permeates the cortex. It is a vascular tumor and metastasizes to the lung early. While the first symptom is pain, by the time this is noticed, the condition may be very advanced. The combined resources of the clinician, radiologist and pathologist are needed in making the diagnosis. By x-ray about one-sixth of the cases show a characteristic sun-ray appearance of the tumor, although parallel striations may also be seen in a large group. Neither of these appearances are pathognomonic of osteogenic sarcoma. Lipping of the periosteum is usually seen by x-ray. An untreated case shows no definite margins of tumor as it blends off into the soft tissues.

The treatment by surgery is unsatisfactory as it is by any other means. A large percentage of patients die within two or three years. Resection or excision of the tumor is rarely possible, so that amputation is usually necessary. Kolodny recommends immobilization of the part, with radiation and amputation after a few months. He then gives prophylactic radiation to the chest.

Ewing's sarcoma is made up of small polyhedral cells with elongated nuclei. There is very little intercellular material. The long bones are the ones chiefly involved and metastases occur to other bones. The symptoms of onset resemble those of osteomyelitis,—trauma frequently, an acute febrile course with leucocytosis, intermittent pain and finally an obvious tumor. This tumor responds rapidly to radiation, helping in the diagnosis, but eventually radiation is non-effective. Radiation appears to be more effective than surgery, but the prognosis is poor.

Myeloma occurs in the mid-portion of long bones and in flat bones. The cells in this tumor closely resemble bone marrow cells. Lack of symptoms makes early diagnosis improbable. Many bones are involved as a rule. Radiation is the treatment of choice unless the tumor is single when it may be excised.

Angio-endothelioma and extraperiosteal sarcoma are discussed very briefly. The Registry material has but few of either type. However the giant-cell tumor is dealt with at some length. Many reported cases of "bone sarcoma" have turned out to be giant-cell tumors. This tumor involves the epiphyses in the large majority of cases, involves the small bones of the extremities more than the malignant types do, but is found chiefly in the lower end of the femur and the upper end of the tibia.

By x-ray the tumor casts a bulky spherical shadow with a multicystic appearance. There is a fairly definite outline to the tumor and it does not affect the periosteum or cortex beyond. Frequently the diagnosis can be made only by an exploration. The giant cells under the microscope are typical, and contain numerous nuclei uniformly distributed throughout the central portion of the cell.

The usual treatment is thorough curettage, the application of carbolic and alcohol, followed by radiation to prevent recurrence. Radical measures such as amputation are no longer advised.

The prognosis for life is good; for restoration of function fair.

This is a very valuable treatise on a very important subject. The book is full of excellent illustrations of gross and microscopic sections. The author has made available to the profession a collection of material unlike any other in existence, but only by a tremendous amount of careful study. In some ways, he disagrees with the original Registry Committee, but this all makes for a more interesting discussion of the points in question.

CANCER CONTROL. Report of an International Symposium Held Under the Auspices of the American Society for the Control of Cancer. The Surgical Publishing Company of Chicago, 1927.

This is a report of one of the most interesting and unusual assemblies ever called together. The leading men of this and other countries in the work on cancer gathered to coordinate the work of the internist, the pathologist, the research worker, the surgeon and the roentgenologist. The meeting was held at Lake Mohonk, New York, September 20 to September 24, 1926.

Each paper published in this volume is a concise statement of the cancer situation today as seen by the specialist who wrote it. Rarely has such a collection of papers been published.

A TREATISE ON ORTHOPAEDIC SURGERY. By Royal Whitman. Eighth edition. Philadelphia, Lea and Febiger, 1927. Price $9.00.

This eighth edition on the treatise of orthopaedic surgery first published in 1901 shows the growth and the increased recognition of orthopaedic surgery during this period, for the first issue was a thorough and comprehensive treatment of orthopaedic surgery at that time. Using the plan of the earlier edition, Whitman has followed through the constant changes, diagnoses and treatment, the added knowledge in pathology, and has given to the student a clear idea of the present knowledge on these different subjects.

The observations in reference to the operations on the spine are judicial, and it is valuable to see a conservative tendency in one who has had a large operative experience, who has been able to follow the results, and therefore to compare the end results of both the operative and conservative treatment. The portion devoted to the tubercular affections of joints is given a prominence which it deserves, and particularly at this time with the necessity of recognizing differential diagnosis in different joint diseases, and with the tendency towards radicalism in the operative, rather than to other conservative treatment of this most difficult joint affection. This is especially true at the time when the student needs to begin his career with a true comparative estimate of the value of the different procedures, rather than to be dazzled by the more spectacular methods of treatments.

The chapters on the affections of the foot, especially flat-foot, are to be recommended for particular study. It is a subject on which the author has given different personal observations, and the reader is not left in doubt,—which is also true of practically all of the subjects which are discussed in the book,—of the opinions and advice of the author. The treatment by exercises as well as the description of the different types of affection are especially valuable. This edition is a particularly valuable book for both student and practitioner.

SURGERY: ITS PRINCIPLES AND PRACTICE. By Astley Paston Cooper Ashhurst. Third edition, Philadelphia, Lea and Febiger, 1927. Price $10.00.

Ashhurst's Principles and Practice of Surgery has entered its third edition, thereby testifying to its popularity as a text-book. The title perhaps justifies the allocation of subjects which are as definitely orthopaedic as any in that section on a regional basis, as e.g., when he puts Pott's disease in the section on surgery of the spine, and hip disease and white swelling in a section on diseases of the joints. The implication is that the treatment of Pott's disease belongs in the general surgical field, together with other tuberculous joint lesions, and should not be included in orthopaedic surgery.

Much of what he has to say of orthopaedic conditions is well said, but in certain subjects one is surprised at some of the statements, as when, for example, he speaks of Brodie's abscess as being almost invariably tuberculous, which is most decidedly not true. Again, too little credit is given the influences of normal growth to overcome the deformities of rickets after the disease is over, as is shown by his advocacy of braces in the treatment of bow legs and knock-knee. Nothing but abstention from weight-bearing will prevent development of deformity when the disease is active and no brace will correct it after the process is over. The discussion of birth palsies and internal derangements of the knee are particularly inadequate. In respect to the first, the etiological factors are wrongly emphasized in the light of present day knowledge and as regards treatment in the second, one is left with the impression that in a *bona fide* dislocation of the semilunar cartilage there was a good chance that recovery might take place without removal of the cartilage.

No attempt is made in this review to estimate the value of any of the text except the parts that are generally regarded as orthopaedic. On this basis, it would seem that it had been a mistake to include so much of what is really a specialty in a text-book on general surgery without bringing the special subjects up to date.

BERCK AND ITS TREATMENTS; THE REASONS FOR THEIR SUPERIORITY. By Dr. F. Calot, Third edition, Paris, N. Maloine, 1927.

In this small book Dr. Calot gives a description of the principles and treatment of tuberculosis at the sea coast in Berck. An emphasis is made of the value of heliotherapy, the methods of its employment and the results which have been obtained. The large number of cases of tuberculosis of bone and joint diseases, which are treated at the seaside places on the coast of France, give ample opportunity to study the value of treatment at the seashore, and the results which are obtained by it. The relative value of heliotherapy at the seashore and in the mountains has never been thoroughly agreed upon by various observers, each advocate claiming certain advantages. In this edition, Dr. Calot quotes Sartory and Langlois, that there is twice as much pure air at the seashore as in the forests, and ten times more than in the mountains; that in each cubic meter of air at the seashore there are found four bacteria, in the forests of Fontainebleau, eight, and in the mountains of Chamonix, forty. In Paris, the number varies with the different localities and during different parts of the day, from 170,000 to 9,000,000.

POTASSIUM AND TARTRATES. A REVIEW OF THE LITERATURE ON THEIR PHYSIOLOGICAL EFFECTS. By Ralph W. Webster, Professor of Rush Medical College and Director of the Chicago Laboratory; with a Digest and Bibliography of the Literature by W. A. Brenna, Chicago, The Commonwealth Press, Inc., 1927.

Dr. Webster has called attention to an interesting subject and one which is now having attention. The value and dangers of potassium and tartrates is of particular importance, since these substances are in so frequent and common use, both to medicine and in the household. Dr. Webster gives a very careful and clear discussion of the present knowledge of these substances, their presence in the body, and also discusses the ions of potassium, with their action on muscles, nerves and heart. In addition, the book

gives an extensive bibliography, a bibliography which gives generous abstracts of each of the references and which adds to the very definite value of the book to anyone who desires to familiarize himself with this subject, which Dr. Webster has brought practically up to date in a brief book form.

LE TRAITEMENT DES FRACTURES DU COL DU FEMUR. PAR LA METHODE DU PR. PIERRE DELBET. By Jacques Leveuf and Ch. Girode, Paris, Masson et Cie., 1927.

The authors give a report of 134 cases of fracture of the neck of the femur operated on by the Delbet method and by different operators from 1907 to 1924. The indications for operation are based on a study of the end results of ninety cases. The book is divided into two parts; the first part gives the statistics of 134 operations, with analysis of ninety end results including fractures treated by the screws, by bone grafts and implantation of dead bone. The second part discusses the indications for operations, technique and end results.

Each part is thoroughly considered and discussed and there are given drawings of x-rays of many tubercular cases several years afterwards, showing the results of securing the head to the neck by the different methods of screw and bone graft, and transplantation of bone. The technique of the operation is particularly well described and comparison is made of the relative value of the different methods.

The book is particularly valuable in the presentation of the end results of the treatment of this subject by the various modifications of the treatment of Delbet and is a contribution to the knowledge of this difficult problem.

INTERNATIONAL CLINICS. Thirty-seventh Series, Philadelphia, J. B. Lippincott Company, Volume IV, 1927.

This volume includes a paper by Professor Patrik Haglund which is actually a report of the visit by members of the Interstate Post Graduate Assembly of North America to the Orthopaedic Clinic of the Caroline Institute in Stockholm. Professor Haglund explains the conditions in Sweden, especially with reference to the sequellae of anterior poliomyelitis, and outlines the organization and methods of work at the Clinic. The fine illustrations of the article give a hint of the interesting demonstrations which must have been enjoyed by the visitors. The article is worthy of the careful perusal of those interested in the organization of the care of the cripples.

The *Journal* wishes to acknowledge the receipt of the following books sent to the Editorial Department:

International Clinics. Thirty-seventh Series, Philadelphia and London, J. B. Lippincott Company, Volume III, 1927.

China Medical Board of the Rockefeller Foundation. Twelfth Annual Report, New York, 1927.

Announcements of the Medical Schools of the University of Chicago, The University of Chicago Press, Chicago, 1927.

The Caduceus, Journal of the Hongkong University Medical Society, Hongkong. Volumes V and VI, 1926 and 1927.

United Fruit Company, Medical Department, Fifteenth Annual Report, Boston, 1926.

THE PATHOLOGICAL ANATOMY OF THE VERTEBRAE. By Schmorl. *Verhandlungen der Deutschen Orthopadischen Gesellschaft, XXI Kongress.*

This paper, based upon a systematic examination of the spine in 1,142 autopsies performed by one of the greatest masters of bone pathology, represents a significant contribution to the study of diseases of the spine. Certain anatomical characteristics

are significant, says Schmorl, in opening his paper. Each vertebra consists of a thin layer of cortex and layers of spongiosa, some parallel to longitudinal axes, others cutting these at right angles. The vertebra is covered at each end with a layer of hard bone, called the end plate or pressure plate. The intervertebral discs consist of three parts: (1) an outer layer, the nucleus-fibrosis whose outer fibers are very densely placed, whose inner gradually merge with the soft, elastic; (2) nucleus pulposus. Schmorl stresses the peculiar elasticity of this structure, comparing it to a bag of water which can change its form easily, and at the same time can exert tremendous pressure. (3) A layer of flattened cartilaginous cells, which line the disc above and below. They correspond to hyaline cartilage of true joints.

1. Infectious Diseases.

Not only after typhoid fever may there be a spondylitis, but also after streptococcus infections, influenza, smallpox, acute glanders. As a rule small foci are found, yellowish-white of pin-head size. Sometimes only a few are seen; in other cases they are scattered throughout the spine. Usually the infecting organism could be cultured from these foci. Complete destruction of vertebra was found in one case of post-typhoid infection, and in a second after a fatal throat infection. Following influenza, the vertebra became markedly wedge-shaped, causing a severe kyphosis. In ten cases tuberculosis of the vertebra was found. In only one of the entire series could syphilitic changes be definitely shown.

2. Blood Diseases.

The marrow of the vertebrae showed changes corresponding to those found in marrow of other bones. In chronic leucaemia there is sclerosis of bone marrow, in acute leucaemia extensive necrosis of the marrow.

3. Tumors.

Multiple myeloma was found six times, although clinically it had been diagnosed only twice. In two cases it had caused collapse of the vertebra with a compression myelitis. Most numerous of all the tumors were the angiomas. They were found in ten per cent. of the series. Sometimes they were as small as grains of pepper, at other times as large as the entire vertebra. Even in these extensive cases, however, they caused no external damage of form. This was probably due to a thickening of the spongiosa in the neighborhood of the angioma. Of the metatastic malignant tumors much the most frequent were the carcinomas. Then came hypernephromas, finally the sarcomas. These tumors did not in all cases produce bone absorption. In a smaller percentage they caused productive bone damages. This so called "osteoplastic type" first described by Von Recklinghausen, was noted most frequently as a sequel of cancer of the prostate. In some instances there were mixed forms, with bone absorption and new bone production. Only in exceptional instances were the discs invaded by the cancer.

4. Rickets, Osteomalacia, Osteopathia, Fibrosa, Osteoporosis.

Schmorl believes that many deformities of vertebrae are due to late rickets (rachitis tarda). This disease merges quite imperceptibly with osteomalacia. Morphologically the two are so closely similar as to be indistinguishable. Recently Schmorl has found endochondral disturbances in osteomalacia, exactly like those in rickets. In osteomalacia the vertebrae frequently develop a peculiar fish-like form, owing to their softening and the ingrowth of the intervertebral discs.

Under the term osteopathica-fibrosa, Schmorl includes the osteitis deformans of Paget and the osteitis fibrosa of Von Recklinghausen. Of twenty-eight cases, twenty-five were found to involve the vertebrae. The changes were usually situated in the lumbar spine and the sacrum. If, as a rule, few vertebrae were involved, there was no change in the form of the spine. If, however, the disease was extensive, deformities ensued. Frequently the discs were involved by an ingrowth of the fibrous marrow, characteristic of the disease. This led subsequently to an ossification of the discs, and an ankylosis.

Osteoporosis is responsible for most of the deformities of the spine seen in older individuals. As Pommer pointed out, this disease is caused by persistence of normal

process of bone absorption, combined with a failure to produce new bone. It was found in 257 cases (twenty-two and one-half per cent.). The deformity is greatest in those cases in which the discs remain intact. When the discs have degenerated new bone forms near their edges, preventing in part development of deformities. When, however, this does not occur, the discs invade the vertebrae almost to the extent of their complete destruction. Microscopically these changes can be beautifully traced: the spongiosa atrophies, the end or pressure plate becomes very thin, and then disappears in spots. The hyaline cartilage layer of disc is then perforated by the nucleus pulposus which rapidly invades the vertebra.

A peculiar feature hitherto undescribed, is the development of little cartilaginous nodules (Knorpelknötchen) springing from intervertebral discs. Although present in thirty-five per cent., Schmorl could find no previous description of these bodies. Sometimes they were so small as to be recognized only by the microscope, in other cases they were as large as cherry stones. They are formed by an extension of the nucleus pulposus into the spongiosa of the vertebrae. Thus far no clinical significance could be attached to these bodies. They are not to be confused with little cartilaginous nodules also found in spondylitis deformans.

5. Lesions of the Intervertebral Discs.

In two cases complete rupture of disc was found, after operations performed in Trendelenberg position. In each instance it was the disc between the fourth and fifth lumbar. A degeneration of the discs was very frequent (forty-seven per cent.). It showed itself usually as a yellowish-brown discoloration of the nucleus pulposus. This degeneration of the discs Schmorl considers one of the important factors in development of spondylitis deformans (found in forty-two per cent.). The degeneration of the disc may lead to sclerosis of the bone, caused by the impact of the pressure plates of the vertebrae against one another without intervention of the elastic disc, or in other cases it may lead to osteoporosis.

Ankylosis may develop in three different ways:

1. Through an ossification of the loose tissue situated between the bodies of the vertebrae and the anterior ligament. This is frequent in spondylitis deformans.
2. By an inflammatory process in the small joints between the vertebrae, first described by Bechterew, Strümpel, and Pièrre Marié. This latter type is not characteristic of spondylitis deformans. Schmorl found it to be very rare.
3. From an ossification of the discs, due to an ingrowth of blood vessels carrying osteoblasts with them.

6. The last section of the paper is devoted to a most interesting analysis of traumata to the spine. Schmorl wished particularly to find some pathological explanation for the late development of deformity in Kümmell's disease. He was fortunate to find in his series two cases of fracture of the spine, showing typical deformity of Kümmell's disease. He also found a number of unrecognized fractures of the spine. These cases showed quite definitely that a fracture extended through the end or pressure plate of the vertebra and thus gave opportunity for the nucleus pulposus to invade the spongiosa in somewhat the same manner as Schmorl had previously observed in cases of osteoporosis. His explanation of the late development of deformity is based upon these pathological data: the patient apparently recovers from the injury; the fracture of the end plate, however, permits the ingress of the nucleus pulposus which gradually causes such extensive destruction of the vertebra as to lead to its complete collapse.

This abstract, though given in greater detail than most, does but scant justice to the original paper which ought to be studied by every reader of the *Journal*.—*Leo Mayer, M.D., New York.*

The Aplasias of the Clavicle. M. G. Huc. *Ann. d'anat. pathol. et d'anat. normale medico-chirurgicale*, IV, No. 3, 267, March 1927.

The total aplasias are rare but have been known for a long time. The partial

aplasia is frequent, but not described; it gives, however, more trouble than the total aplasia.

Normally the scapula girdle is united to the thorax by the sternoclavicular articulation. The acromioclavicular articulation is somewhat less mobile (ten degrees). The scapula is a veritable inscribing pen which multiplies and makes evident the sternoclavicular movements. The cleidoscapula belt caps, like a hat, the dome of the thorax. If this one is underdeveloped, there will be a lowering of the scapula (the hat is too large). If there is a partial clavicular aplasia, (the hat is too small) there is seen an elevation of the scapula. Normally the superior surface of the clavicle is horizontal, its line which is projected passes at the level or just above the level of the manubrium. The upper border of the scapula corresponds normally to the second rib, the inferior angle to the seventh. The movements of the scapula are about an axis situated at the middle portion of the scapula in the subspinous fossa from three to four centimeters from the spinal border of the bone.

It is the current observation that the new-born child has no neck. The scapula border is notably raised, and does not contract to its normal relations before the age of four years.

In the "clavicular aplasia" the clavicle appears oblique from above and from the outside, shortened, and its curves straightened and slender. The scapula is raised and the inferior angle corresponds to the fourth or fifth rib. The spinal border is removed from the spine. The axillary border tends toward the horizontal; the scapula is rarely atrophied. One can sometimes observe the exostoses or the bony scapulovertebral bridges. These malformations appear to be from musculotendinous ossification. When the movements of the scapula border are limited, it is the result of the contact of the clavicle with the first rib. The movements of the shoulder are normal. There is seen a slight degree of secondary scoliosis and often a thoracic aplasia on the same rib. The x-rays should be taken in the standing position.

From the clinical point of view, the fact which is the most remarkable is the late appearance of the symptoms, usually near the age of ten years. The diagnosis should be made by the displacement of the scapula with a scoliotic gibbus,—with the simple scapula aplasia (without interference of function).

The pathogenesis of these congenital elevations of the scapula have been very much disputed. One has considered from time to time the vicious attitudes of the foetus (amniotic bands), particularly the defect in the course of development, and the lowering of the scapula belt (Ragès). The author makes the statement that up to now no one has completely understood the rôle of the clavicular aplasia. Moreover, the author makes the remark that with the foetus, the scapula belt is already in its normal place. The anomaly of development is, therefore, embryonic and not foetal. The knowledge of today does not permit one, therefore, to say that the scapula belt is a formation of cervical origin. If there is breaking away, one can understand rather a departure from below above, then from above below. It is at present impossible to give a precise pathogenic explanation.

The treatment should be: first, treatment of the scoliosis by gymnastics; second, fixation of the scapula in certain cases at the level of the axis of rotation, and in others, provisional at the level of the point; third, if necessary, elongation of the clavicle in order to avoid in the course of lowering, all compression of the bundle of vascules and nerves. —*Docteur M. Galland, Berck-Plage.*

SURGICAL ANATOMY OF THE CELLULAR SPACES OF THE HAND AND FINGERS, ITS SURGICAL IMPORTANCE IN DETERMINING NEW INCISIONS. By Marc Iselin. *Ann. d'anat. pathol. et d'anat. normale medico-chirurgicale*, IV, No. 6, 603, June 1927.

The author recalls the work of Kanavel. His personal work has been made with injection into the sheath of the fingers with a mixture of plaster and with barium. The injections have been pushed to the rupture of the sheath of one part and the formation of a fusion of the other.

From this work is shown that the lumbrical area is the channel of communication between the cellular spaces of the fingers and those of the hand. It is here that it is necessary to search for pus after opening a subcutaneous infection of the first phalanges of the fingers. This way of communication gives passage from the median palmar space without communication with the thenar space on the one hand, and with the hypothenar space, on the other.

The conclusions are somewhat different from those of Kanavel. The median palmar space is regarded as more important. The phlegmons of this area should be incised at the level of the tract of lumbrical communication. The median palmar space can be equally infected through the medium of the tendon sheaths. Moreover, these palmar and dorsal spaces communicate at the level of the union, from the same level with the thenar space. This fact demands a connecting incision for the phlegmons of thenar location in order to explore and fully drain the palmar and dorsal spaces. The deep spaces of the forearm communicate with the fingers only through the intermediary of the large carpal tendons, radial or ulnar. The sheaths always break at their extremities above and deep. The cellular space which is invaded is between the pronator area and the deep surface of the sheath, and is continued along the sheath of the vessels and nerves.

These considerations suggest entrance by the lateral tracks in front of the radius and ulna.—*Docteur M. Galland, Berck-Plage.*

Prognosis and Treatment of Giant-Cell Sarcoma. W. B. Coley. *Ann. Surg.*, LXXXVI, 641, Nov. 1927.

A series of sixty-nine cases is reported and the author forms conclusions on two unsettled points, namely: (1) Whether giant-cell sarcoma is always a benign lesion, and (2) What is the best method of treating these cases. He takes issue with Bloodgood and others who claim that giant-cell sarcoma is always a benign tumor. He reports cases which have given rise to metastasis and death. Biopsy properly performed is recommended, followed by thorough curettage and cauterization with zinc chlorid or carbolic acid. The danger of hemorrhage must be borne in mind. Packing of the cavity with gauze is recommended. This can be removed in twenty-four to forty-eight hours and Dakin solution used if any infection is present. Coley's serum is used for three to four months after operation. Radiation is advised for a period of one to two years by some, and a few good results are reported even without operation. Several interesting cases are reported and excellent radiograms shown. His conclusions are interesting.—*F. G. Hodgson, M.D., Atlanta, Ga.*

An Operation for Slinging a Dropped Shoulder. Arnold K. Henry. *British J. Surg.*, XV, 95, July 1927.

A method is described by which a case of shoulder-drop was successfully treated by slinging the scapula to the spines of the sixth cervical and third dorsal vertebrae by means of a ten-inch strip of fascia lata. The illustrations are excellent.

Some Notes on the Clinical Features and the Distribution of Secondary Deposits in Bone Following Carcinoma of the Breast. D. H. Patey. *British J. Surg.*, XV., 182, Oct. 1927.

This article is accompanied by excellent diagrams showing the location of cancer deposits in bone in twelve cases. Eighteen cases are discussed in the text. The metastases in these cases were as follows: Spine, twelve; pelvis, eleven; femur, eight; scaphoid, three; humerus, three; intercostosternal region, six. These metastases are grouped into three classes: a diffuse group in which the metastases are widespread; the localized group in which there are but one or two single deposits; and the mixed group which show a combination of the two.

SOME GENERAL DISEASES OF THE SKELETON. H. A. T. Fairbank. *British J. Surg.*, XV, 120, July 1927.

This was the Presidential Address to the British Orthopaedic Association. The following classification of general affections of the skeleton was suggested and the chief essentials mentioned under each:

- Congenital Developmental Errors
  - Osteogenesis imperfecta
  - Diaphysial aclasis
  - Dyschondroplasia
  - Achondroplasia
  - Craniocleido dysostosis
  - Ateleiosis
  - Myositis ossificans idiopathica
- Errors of Metabolism
  - Scurvy
  - Rickets
  - Renal dwarfism
  - Dwarfism associated with:
    1. Coeliac disease
    2. Pancreatic disorder
    3. Hypertrophic cirrhosis of liver
- Endocrine Errors
  - Gigantism
  - Acromegaly
  - Mollities ossium
  - Osteomalacia
  - Dwarfism and infantilism of various types
- Affections of Unknown Origin
  - Fibrocystic disease
  - Leontiasis
  - Osteitis deformans
  - Arachnodactyly
- Multiple Neoplasms

THE RELATION OF TUBERCULOSIS TO KÖHLER'S DISEASE. H. H. Greenwood. *British J. Surg.*, XV, 245, Oct. 1927.

A diagnosis of Köhler's disease is justified if the following criteria obtain:

1. The affected bone is smaller than normal.
2. The outline of the bone is irregular.
3. The density of the bone is increased.
4. The architecture of the bony trabeculae has disappeared.
5. The general shape of the scaphoid is altered, being flattened from before back.

The writer describes a case which showed all these signs by x-ray. The foot was immobilized in plaster. Five weeks later fluctuation could be felt on removal of the cast. Aspiration was done and pneumococci obtained. No tubercle bacilli were found. Two weeks later there was an acute inflammatory process which required multiple incisions. Pathological examination showed no tuberculosis or malignant disease. Ten months later amputation was done. Typical tuberculous granular tissue with secondary pyogenic infection was found.

The writer believes that this case was similar to those usually classified as Köhler's disease. He believes, however, that the B. tuberculosis accompanied the pneumococci through the blood stream and that the former finally predominated.

FRACTURES OF THE UPPER END OF THE FEMUR. George F. Stebbing. *British J. Surg.*, XV, 201, Oct. 1927.

This article gives an interesting resumé of the methods of treatment of fractures of the upper end of the femur. In a group of 341 cases it was found that fractures through the great trochanter are twice as common as fractures through the neck. Fractures through the neck are three times as common in females as in males. The average age of the patients in the series was sixty-nine. These patients were all inmates of a chronic hospital where they came with the expectation of spending their last days. The end results are therefore of little merit. In 111 fractures of the neck of the femur, thirty-one died before leaving the hospital. Of 207 trochanter fractures, fifty-one died and of twenty-three subtrochanteric fractures, six died. No results as to the ultimate function or the amount of disability are given.

ARTHRODESIS OF THE WRIST. M. Raphael Massart. *Bull. et mém. Soc. de Chir. de Paris*, XIX, No. 12, 489, July 1927.

The author reports the lack of permanence and the uncertain results of tendon transplantation. He proposes, therefore, a technique for arthrodesis of the wrist for flail wrist, club-hand and for ankylosis in flexion.

He advocates the position of slight extension of from fifteen to twenty degrees in order to give the interosseous and lumbricales their maximum action, and advises a transverse incision at the base of the third metacarpal, on each extremity of which is made a cross perpendicular incision. The extensor tendons are not only preserved, but are detached from the bone with the rasp, separating entirely the fibroperiosteal attachments which cover and hold together the radius, ulna, and bones of the wrist. The study of the movements of the wrist show that the most mobile articulation is the radiocarpal. The osseous section is made by a chisel. It should be oblique in a way to raise the radius more than the ulna; this latter is preserved in order that it may play the rôle of buffer, with the idea that it may oppose itself to a later ulnar inclination.

The tendons are puckered in order to obtain their shortening and finally immobilization in plaster is necessary. The author has furnished observations which are very encouraging.—*Docteur M. Galland, Berck-Plage.*

REPORT CONCERNING PLATYSPONDYLISIS. IS IT LOCAL OR DOES IT EXTEND TO THE WHOLE SPINE? Lance. *Bull. et mém. Soc. de Chir.*, LIII, No. 4, 132, Feb. 12, 1927.

In 1900 Putti drew attention to the fact that most of the cases with rachischisis have a marked flattening of the vertebral bodies, and created the name platyspondylisis to designate it. Furthermore he said that this malformation is the only possible sign by which to differentiate the deformities of rachis, such as spina bifida, from delayed ossification which is so often present in children.

Lance found that this condition not only exists with both classes of spina bifida, but he has also seen it in cases of somatoschisis, and in two the flattening involved the entire spine without another anomaly present.—*Felipe Muro, M.D., Farmington, Mich.*

A CASE OF RECURRING SARCOMA. Wilkins. *Can. Med. Assn. J.*, XVII, 1058, Sept. 1927.

Female, aged ten, in the year 1921, fell while skating, injuring her right shoulder. In July 1923 she was admitted to hospital for swelling of the right clavicle first noted two months previously. The clavicle was removed. The pathological report was "a small round-cell sarcoma, periosteal type". She was free from recurrence for a period of at least eighteen months when metastases recurred in the skull during the early part of 1925. About five months later there was a second recurrence, namely in the spinal

column and in the skull. The third recurrence was five months later in the pelvis, and the fourth was about eight months later in the skull. All the skiagrams showed bone destruction, but excepting the primary growth in the clavicle, where there was definite medullary invasion, the bone destruction in the metastases was from external pressure and not from actual invasion of the medulla. The primary lesion in the clavicle showed definite osteogenesis; the metastases showed little or none. Bone regeneration occurred readily in the skull and in the pelvis but did not occur in the vertebrae. A further feature of great interest was the ready response to comparatively moderate doses of x-ray.

About ten days after the paper was read the patient again reported. There was no complaint but routine examination showed recurrences in the left hip, in the pelvis, the fourth lumbar vertebra and in the skull. A further course of x-ray treatment was instituted.

(*Comment by abstractor.*)

(The age of this patient, the history of injury some months previously, the metastasis to bone, particularly the skull, and the ready response to x-ray treatment suggest that this is a case of Ewing's tumor. In the absence of detailed histological report or illustration, it is not possible to be certain on this point.)—*A. Gibson, F.R.C.S., Winnipeg, Man.*

SPONTANEOUS GANGRENE OF THE EXTREMITIES. Dean Lewis. *Can. Med. Assn. J.*, XVII, 1125, Oct. 1927.

Clinically spontaneous gangrene occurs in the old: senile, degenerative; and in the young: presenile, inflammatory, a thrombo-angiitis. The changes associated with presenile gangrene are definite. Pathologically arteriosclerosis and thrombo-angiitis are different. In thrombo-angiitis inflammation of the vessels and surrounding tissue are the initial lesions. In the evolution of the disease, healing is the rule, the products of the inflammatory stage being replaced by fibrous tissue. The material of study consisted of 139 cases of spontaneous gangrene. Of these forty-seven were arteriosclerosis, forty-three arteriosclerosis associated with glycosuria, twenty-seven cases of diabetes without pronounced arterial changes, fourteen cases of thrombo-angiitis obliterans, one case of scleroderma, and seven cases in which infection played the principal part.

*Arteriosclerotic Gangrene.*

Pott's original description is quoted in full; it remains accurate to this day. Why is gangrene more common in the lower extremities? The arrangement of vessels may determine this. In eleven of twenty cases examined by Heidenhain occlusion of the large vessels by thrombi was found. In fifty per cent. of cases of senile gangrene, the large vessels of the extremity are occluded.

Nine deaths occurred in the forty-seven cases. Twenty-seven patients left hospital with wounds healed. All the cases could not be followed subsequently, but in two, gangrene developed in the remaining foot, one almost nine years after the first amputation, in the other case almost four years later. In some cases the incision may open after removal of the stitches. Death is not often caused by the operation, but by extension of the vascular disease or a terminal infection.

*Arteriosclerotic Gangrene with Glycosuria (Diabetic Gangrene).*

Arterial changes are common in patients with diabetes. Eliason and Wright found arteriosclerosis in sixty-six per cent. of cases of diabetic gangrene and in one hundred per cent. of cases undergoing pathological and x-ray examination.

Accumulating evidence indicates that the so called diabetic gangrene is due to arteriosclerosis. It develops in the diabetic about a decade earlier than in uncomplicated arteriosclerosis, the average age being fifty-four years.

In seventy of Lewis' cases arteriosclerotic changes were observed.

*Thrombo-Angiitis Obliterans.*

The presenile type shows quite a different picture. It may have a variety of

onsets; intermittent claudication or trophic changes. It is not confined to Hebrews. An extensive collateral circulation may develop. While some collateral circulation may develop in arteriosclerosis it is never marked. Injection of the vessels of legs amputated for this condition showed loss of normal arrangement of vessels, and in the main vessels patchy defects suggesting almost complete obliteration of the lumen at some points. There is a limit to the speed at which collateral circulation can develop. The outcome of the disease is determined by the relative speed of the two processes. It is probable that the site of the thrombus may modify the clinical course.

A case is described rather fully. Male forty-seven. German. Onset seven years before with pains in calves. One and one-half years later pain in the right arm. When the legs were permitted to hang over the side of the bed the feet became bluish red and engorged. It was suggested that the femoral artery be tied. This was done. During the night the patient became hemiplegic and died. The autopsy showed that at the level of the coeliac axis the aorta suddenly became reduced in diameter. An old organized thrombus extended from here to the bifurcation. Thrombosis affected external and internal iliacs on both sides. Total occlusion of the second portion of the right subclavian existed; this extended into the axillary and brachials.

This shows how extensive thrombosis may be and function still be maintained by a collateral circulation. The indication in treatment would appear to be to force the collateral circulation ahead of the advancing thrombus. Four out of seven cases were improved by ligation of the femoral artery.

*Control of pain.*—In some cases the pain is a true arterial pain. The operation puts at rest the inflamed artery. The final result will depend upon whether or not the collaterals which develop are diseased.

In the treatment of diabetic gangrene there must be the closest cooperation between surgeon and internist. Insulin has changed the outlook. It cannot, however, be expected to aid much in limiting gangrene, for this depends on the same mechanism as arteriosclerosis. Either a transcondyloid or a Gritti-Stokes is the best amputation.

In thrombo-angiitis obliterans we are dealing with another process in which the development of a collateral circulation is a striking feature. We can attempt to keep this ahead of the advancing thrombus by ligating the femoral artery below the profunda, or, if amputation is necessary, the collateral circulation may be sufficient to permit of an amputation through the leg.—*A. Gibson, F.R.C.S., Winnipeg, Man.*

EWING'S SARCOMA: REPORT OF A CASE. J. E. Pritchard. *Can. Med. Assn. J.*, XVII, 1164, Oct. 1927.

Although it represents about seven per cent. of all cases of bone sarcoma, the recorded cases of Ewing's tumor are comparatively few. A brief summary of the characteristics of this tumor is given from the pages of Kolodny's study.

Female, eighteen. Sustained injury to right arm in February 1926. The pain continued intermittently, becoming continuous five months later. She was admitted to hospital, July 1926. Right arm was tender and elbow movements were painful. Temperature was raised and remained so almost continuously. X-rays showed elevation of periosteum. The case was diagnosed as osteomyelitis and incision was made. The pathologist reported inflammatory tissue or sarcoma, probably the latter. Following operation the tumor rapidly increased in size and there was a profuse discharge. Radiation was carried out. Patient left hospital September 1926, the arm being still swollen and the temperature raised. She was readmitted in October 1926. The right arm was smaller, but there was pain in back, left shoulder and over left iliac crest. At the latter site there was a soft, red, tender swelling. It was incised. Temperature remained elevated, there was vomiting, pain was constant, and on December 9 right-sided paralysis, choked disc, nystagmus, and impaired hearing were present. A large soft tumor developed over the cranial vault. Her condition gradually grew worse and she died on February 19, 1927, approximately one year after the injury to the right arm.

Autopsy showed all the soft tissues of the arm infiltrated with what appeared to be malignant growth. The tumor occupied the whole shaft of the humerus. The bodies of two vertebrae were considerably softened. In the upper part of the sternum there were two small necrotic lesions. On the right side of the cranial vault there was a soft mass. On the inner side of the skull cap there was a great formation of small bony spicules. There was no tumor at the base of the skull nor in the brain.

Microscopically there were strands of connective tissue dividing the tumor into irregular lobules which contained sheets of small polyhedral cells. Many of these showed mitotic figures. In places the cells had fused into a syncytium, but no definite tumor cells could be found.—*A. Gibson, F.R.C.S., Winnipeg, Man.*

FOOTBALL INJURIES OF THE KNEE JOINT. Austin and Campbell. *Can. Med. Assn. J.*, XVII, 1324, Nov. 1927.

The cases described were collected almost entirely from the accidents sustained by the Rugby football team of Queen's University during four years.

A description of the ligamentous mechanism of the knee joint is given.

CASE 1. Diagnosed as rupture of the internal lateral ligament of the joint. Treatment three months in plaster followed by several months with a caliper splint. After three years patient walks without discomfort or instability but lateral movement is still obtainable. This case should probably have been operated upon at the beginning.

CASE 2. Was very similar though not so severe. After two months in plaster he was able to play again. After one year there was no abnormal mobility.

CASE 3. Showed lateral movement at the knee. Two and one-half months in plaster did not bring about restitution, as lateral movement was observed seven months later.

CASE 4. Showed lateral movement. Plaster for two and one-half months was followed by much wasting of muscles. Nine months later, cure appeared to be complete.

CASE 5. Rupture of internal lateral ligament. Plaster for two and one-half months. Complete recovery after one year.

CASE 6. Was similar but had not fully recovered after one year.

CASE 7. Diagnosis never fully established. It was thought to be sprain of a crucial ligament. The knee remained weak, and patient has never entirely recovered.

CASE 8. Rupture of external lateral ligament. Recovery more rapid and more complete than in any of the other types.

CASE 9. Dislocation of the internal semilunar cartilage. Operation will have to be performed.

*Treatment.*

A. Massage.
B. Diathermy.
C. Infra-red Rays.
D. Static spark from a Wimshurst machine.

All cases with lateral ligament injury are placed in plaster for not less than two months. The results are on the whole satisfactory, but the question of open operation will have to be considered.

*Conclusions.*

(1) Injury to the knee joint caused more permanent wastage than all other accidents combined.
(2) Of the severe injuries to the knee, rupture of the internal lateral ligament is the commonest.
(3) The prognosis appears fairly good, but there are types that may call for open operation.
(4) The injury occurs most often while on the defensive when the knees are braced for resistance.—*A. Gibson, F.R.C.S., Winnipeg, Man.*

A Case of Osteomyelitis of the Long Bones in an Infant: The Subject of Inherited Syphilis. James Thomson. *Edinburgh Med. J.*, XXXIV, No. 8, Aug. 1927.

Male child, ten weeks old, brought with swelling of right tibia, right elbow, and left wrist. The father was syphilitic. Of the three children of the marriage all had swelling about the joints.

At the age of six weeks swelling of the proximal two-thirds of the right tibia was noticed; one week later a similar swelling developed at the right elbow, and more recently fulness proximal to the left wrist.

Under oral administration of grey powder the swellings rapidly disappeared. Radiographic examination failed to show epiphysitis, but the shaft of the tibia was to a considerable extent irregularly absorbed and the rest of the shaft and the corresponding part of the fibula showed a double outline from newly formed periosteal bone.

Chassard and Enselme state that ossifying periostitis in nurslings is an important sign of syphilis which may be entirely latent elsewhere. Carpenter states that multiple epiphysitis is frequently the sole manifestation of inherited syphilis. The absence of pain in these cases is noteworthy.—*A. Gibson, F.R.C.S., Winnipeg, Man.*

Reduction of Cervical Dislocation. Victor F. Marshall and Clarence C. Reed. *J. Am. Med. Assn.*, LXXXIX, 191, July 16, 1927.

Partial dislocations, with slipping of the articular process on one side forward into the intervertebral notch of the vertebra below are not so rarely seen as generally believed. The patient has a fixed position of the head as in torticollis and cord symptoms may be present or absent.

Attention is called to Walton's plan of reduction by rotation only, and the necessity for proper fixation after reduction emphasized. The author's case had a recurrence during the first twenty-four hours, and, following a second reduction, was kept in a plaster collar with inclusion of the head and shoulders for four weeks with complete recovery.—*W. B. Carrell, M.D., Dallas, Tex.*

Laminectomy. Analysis of a Series of Thirty Cases. Edwin W. Ryerson. *J. Am. Med. Assn.*, LXXXIX, 687, Aug. 27, 1927.

In the series, seven cases were paralysis from Pott's disease. The author believes that laminectomy should be done on suitable cases when improvement has not followed six months of conservative treatment. In some of these cases a bone graft fixation procedure was added to the decompression. Operations for fracture-dislocation of the spine in fourteen cases are reported.

Of seven cervical cases with apparent complete lesion of the cord all died.

Of seven dorsal and lumbar cases, three with complete lesions were not improved. Of four with partial lesions, three are practically well and one improved. Some in this latter group were operated on two years after the injury, and had made little or no progress for the twelve months preceding and were improved after laminectomy.

The author would advise early operation on fractured spines with cord symptoms for the benefit of those which can be relieved by decompression and with the belief that when a complete destruction of the cord is present very little shock is added. Another very interesting case of the series was one with complete relief following the removal of the mass of granulation tissue on the surface of the dura, resulting from an old abscess in osteomyelitis of the fourth dorsal vertebra.

The author proposes an operation, which has not been attempted, for the relief of patients with complete lesions about the first lumbar region, in transplanting intercostal nerves across the lesion for anostomosis with nerves below the injury.—*W. B. Carrell, M.D., Dallas, Tex.*

PHYSICAL THERAPY AND ITS RELATIONSHIP TO ORTHOPAEDIC SURGERY. Albert H. Freiberg. *J. Am. Med. Assn.*, LXXXIX, 782, Sept. 3, 1927.

Any abstract of this paper would not do justice to the author's presentation of the right relationship of physical therapy to modern practise. Expensive and elaborate equipment does not constitute a therapy department. The physician who prescribes any modality in treatment should know what effect it will have on the tissues and it should be ordered for that definite purpose. The value of mechanical apparatus is not minimized but the superficial training gotten by many physicians in the short courses offered by manufacturers of equipment is wholly inadequate. The fundamental principles of physical therapy should be taught in the undergraduate medical school. Technicians need more training than the majority of them get, which too often includes only instruction in how to hook up the machines and apply the electrodes. A nurse's training is an excellent background for beginning the study of physiotherapy, and nurses should be encouraged to specialize in this work.—*W. B. Carrell, M.D., Dallas, Tex.*

HABITUAL DISLOCATION OF THE SHOULDER. W. B. Carrell, Dallas. *J. Am. Med. Assn.*, LXXXIX, 948, Sept. 17, 1927.

The author presents illustrations and describes an operation for the relief of habitual dislocation which combines the principle of tenosuspension and of capsule reefing.

The biceps tendon is exposed and divided at the juncture of the coracoid head, and the distal end fastened to this muscle. The proximal end is freed from sheath upward to where it emerges from joint capsule. To this end a band of fascia, one inch wide and six inches long (removed from thigh) is attached with fascia sutures and the strip is passed through the subscapularis muscle, threaded on a special aneurysm needle, and made to penetrate the joint capsule underneath at two or more points and emerge on posterior region just above the teres minor. A small incision is made from acromion downward, and through this incision the strip is pulled and fastened through a drill hole into the acromion. Four cases are reported with satisfactory function.

The advantages claimed for the operation are that the capsule is strengthened at the weakest point, and in addition the humerus is suspended, not only to the acromion, but also to the glenoid where it anatomically belongs. A slight limitation of outward rotation was observed but no loss of elbow flexion or supination as might be expected from loss of a portion of biceps.

STUDIES ON THROMBO-ANGIITIS OBLITERANS. THE EFFECTIVENESS OF THERAPEUTIC PROCEDURES. Samuel Silbert. *J. Am. Med. Assn.*, LXXXIX, 964, Sept. 17, 1927.

The study of 258 cases included only those with symptoms beginning before the age of forty-five. It was found that seventy-seven per cent. came to amputation within five years from the onset of symptoms.

In a group of eighty-four cases, receiving frequent intravenous injections of hypertonic salt solution, over a period of four years only twelve per cent. had amputations.

The author is convinced that smoking has a definite influence in the etiology and continued smoking has an unfavorable effect on the progress of the disease.—*W. B. Carrell, M.D., Dallas, Tex.*

TUMORS OF CAUDA EQUINA AND SPINAL CORD. George E. Bennett. *J. Am. Med. Assn.*, LXXXIX, 1480, Oct. 29, 1927.

The author gives very detailed histories of four selected cases, all of whom, as he points out, presented (1) variable pain in the spine and nerve roots; (2) extreme spasm of the erector spinae muscles, followed by lateral deformity of the spine; (3) extreme bilateral spasm of the hamstring muscles. He says that all these signs were recorded long before any motor or sensory changes could be found. He states that it is his

opinion that cases of spinal cord lesions come to orthopaedic surgeons earlier than to neurologists or neurosurgeons, because they present these signs and symptoms suggestive more of a bone lesion.—*A. P. MacKinnon, M.D., Winnipeg, Man.*

TREATMENT OF FRACTURES OF THE OS CALCIS BY ARTHRODESIS OF THE SUBASTRAGALOID JOINT. Philip D. Wilson. *J. Am. Med. Assn.*, LXXXIX, 1676, Nov. 12, 1927.

The author calls attention to the serious percentage of disability following these fractures, and makes a strong plea for treatment by arthrodesis in recent as well as old cases. He employs the lateral approach. He takes pains to remove the cartilage from all three articular facets between calcaneus and astragalus, and in some cases fuses the mediotarsal joint as well. In recent cases deformity is corrected as nearly as possible, and in old cases bone is removed from the lateral surface of the os calcis rather widely beneath the lateral malleolus.

Twenty-six patients have been operated upon in the last three years. Three of these are recent, and in three, the results are unknown. One only was a failure. But the remarkable statement is made that seventeen of the other twenty cases are back to work at their old jobs, earning full wages, in an average time of only seven and a half months after operation. The recent cases did better than the older ones.—*A. P. MacKinnon, M.D., Winnipeg, Man.*

NOTE ON SOME STRUCTURAL MODIFICATIONS OF THE HIP, NORMAL AND PATHOLOGICAL. Duvernay and Parent. *Lyon Chirurgical*, XXIV, No. 4, 440, July-August, 1927.

I. The Double Cavity

The double cavity is the name given the condition seen in the radiogram which shows the two internal walls or partitions of the acetabulum; the first normal being formed by the U radiogram, the second descends like a curtain in front of the first, extending the concavity of the roof of the acetabulum. The term double wall could be used as well.

It is possible to develop the image of a false double wall by a variation of the angle of inclination in taking the ray, but the double wall is formed by the ilio-ischiatic line cutting by a clear intersection the cotyloid cavity. It is possible, on the other hand, to disguise the image of a true double wall by a modification of this angle of inclination. The double wall is a reality, it is made by a thin osseous plate, which generally is smooth, obstructing like a lid the surface on the posterior part of the acetabulum (between the two horns); the round ligament is inserted on the posterior surface under this osseous plate. There can exist a double osteophytic wall.

The authors have not observed this double wall before the age of eleven years. Therefore it is not contemporaneous with the luxations. The authors consider the double surface as a secondary ossification of the superficial portion of the round ligament, consecutive to its compression (cotyloid ligament less deep).

II. Front Portion of the Roof or "the Shed".

This is an exaggeration of the projection of the cotyloid roof which is elongated toward the outside. It is an acquired osteophytic formation and generally belongs to adults. It is neither congenital nor indicative of subluxations.

III. The Threshold.

This is a radiograph projection of the cotyloid cavity below and transforming its usual form of a half circle to a semi-circle more or less complete. It is not equally suggestive of subluxation, but is frequently seen in the proliferative arthritides. It is an osseous production, formed generally at the expense of the posterior horn, rarely of the anterior horn.

IV. The Ovalization of the Cotyloid and the Elevation of the Head.

The cotyloid type is hemispherical, well centered, of half-orange shape. The cotyloid oval is one in which the superior border is more or less straightened and of a half-

citron shape (Calot). There is the question, therefore, of a congenital anomaly, but it must not be confused with subluxation and subluxable hips. Moreover, the bony ovalization does not take on the cartilaginous form of the cotyloid, so in the widened pelvis with spreading alae, an oval cotyloid cavity can easily hold the femoral head. The frequency of this condition of ovalization reaches nearly nine-tenths of the hips one can examine. There should not, therefore, be attributed to it too great importance when it is seen simultaneously with displacement of the femoral head.—*Docteur M. Galland, Berck-Plage.*

Malleolar Fractures and Supramalleolar Fractures. C. E. Corlette. *Med. J. Australia*, XIV, 76, July 16, 1927.

This is a very comprehensive article. The fundamental surgical anatomy is first discussed. The central portions of the ankle joint ligament, both inner and outer, are extremely strong and are quite unlikely to be ruptured in either inversion or eversion fractures of the malleolus. A part of the bone, usually including the malleolar attachment of the ligament, is, as a rule, fractured off before the middle portion of the ligament is torn. The anterior ankle joint ligament is comparatively thin and is very often ruptured in malleolar fractures. In experiments on the cadaver the author proved that the fibula could be fractured by forcible abduction of the foot by which the os calcis was made to impinge on the lower end of the fibula; and that this fracture could take place without rupture of any ligament. In the more severe cases the anterior joint ligament is usually torn across. Both malleoli may be broken and also a portion of the articular surface of the tibia may be knocked off by impingement of the astragalus. In these severe injuries the lower fragments move with the foot, their ligamentary attachments to the calcis and astragalus remaining for the most part unruptured.

The most difficult fractures of all to treat are those in which both malleoli are fractured and a portion of the articular surface of the tibia is split off by the impact of the talus, the foot being displaced backward and carrying the lower fragment with it.

In the treatment of the more severe fractures reduction should be done at the earliest possible moment. The author feels that a good anatomical position is the one absolute essential to successful treatment and that having gained this the end results will be good, either with, or without, physiotherapy. The most difficult deformity to control is the backward displacement of the foot, especially where there is a displaced posterior split of the tibia.

Even in the milder cases the author does not begin massage and passive movement early because of the risk of sacrificing position of the bone. In the majority of cases he keeps the foot in plaster for about seven weeks and then physiotherapy is begun, weight-bearing being allowed after eight weeks. In the more severe cases the date of walking is postponed for another two or three weeks. Ordinarily the author does not use a brace.

The author's method of treatment is based on the fact that the lateral ankle joint ligament is very seldom ruptured and that in traction on the foot, the fibula malleolus is pulled down through the attached lateral ligaments. Having failed in the attempt to make traction on the foot through plaster-of-Paris, or by a hitch about the ankle, or by Sinclair's skate and glue, he then resorted to skeletal traction, first with a Steinmann pin, and later with an ordinary gimlet. Over this was hooked a strong wire, to form a tractor, with loops in it which enabled the line of pull to be made on either side or in the middle. This apparatus was comfortable and obtained excellent results. The gimlet was never left in longer than two weeks, at the end of which time the foot and leg were encased in plaster-of-Paris with the traction apparatus still on, the gimlet being removed the next day.

Being dissatisfied with the necessity for making a hole through the os calcis and fearing the possibility of an osteomyelitis if the wound became infected, the author devised what he called a "spring tractor". The instrument is made of number five Imperial standard wire gauge spring steel; the points bent back at an angle of about

forty-five degrees; the instrument made in the shape of a square "U", with a loop in each corner and in the center of the base, so that the pull may be from either side or from the center. The "U" is so bent that the points come close together. This instrument is sprung in on the tuberosity of the os calcis well back, the points resting at, or above, the widest part of the bone. The skin is not incised, the points of puncture being well above the bony points that are to be gripped, but not so high as to pull any skin down. The grip on the bone is so strong that the patient can be pulled off the table. The leg is then adjusted in a ring splint, the cord attached usually to the loop on the fibular side, carried over a pulley, and a five-pound weight is attached, the line of attachment being a little upward from the line of the leg. The position of the foot is controlled by a piece of adhesive plaster to the sole and a line to the Balkan frame with a separate weight of two pounds. The pull on the lateral loop of the tractor keeps the foot in a slightly overcorrected position. The tractor is said never to be uncomfortable, and the skin fits snugly around the tines and blocks the entrance of infection. There is no reaction around the puncture and no tendency to suppurate. Pain is always caused by dragging on the soft parts and proper application of the tractor will prevent this.

This method is said to give excellent control of position, the pull being changed from one side to the other of the tractor as made necessary to control an abduction or adduction deformity. The foot is kept in extension for from one to two weeks, and a plaster cast is applied with the tractor still in position and the foot still in overcorrection. When the plaster is dry the tractor is removed. The pull from the os calcis counteracts the tendency to foot drop and to backward displacement of the foot, while the overcorrection allows the torn ends of ligaments to approximate. This method is particularly applicable to compound fractures and is equally effective in supramalleolar fractures. It is also applicable to fractures higher in the leg, especially where there is overriding. When the pull is made from the center of the tractor, the traction being on both sides, a weight of twenty to thirty pounds may be used if necessary. Where traction has to be continued for a longer period a second tractor may be introduced in a new place on the bone.—*Edward N. Reed, M.D., Santa Monica, Calif.*

Muscle Tone. N. D. Royle. *Med. J. Australia*—Supplement No. 5; 130, Sept. 10, 1927.

Starling's definition of muscle tone, that it is that slight continued contraction which keeps the muscle tense and without "slack", is a misstatement because slack is present in normal muscles which are not contracting actively, and contrary to the definition, muscles do not retract when cut across, unless they are in active contraction at the time.

Sherrington's definition is that tone is a proprioceptive reflex mechanism concerning posture and to this the author subscribes, adding that it is present to any degree only in muscles subjected to stretching, as in maintaining a posture, or in muscles about to go into action in response to an idea of movement; and is not present in resting muscles.

The author found that removal of the sympathetic nerves from the limb of a normal animal did not interfere with the control of the limb, but did abolish the lengthening-and-shortening reaction which appears in normal limbs during anaesthesia, and that it removed all definite resistance to passive movement.

In a spinal animal, when placed on its back, there was a distinct difference in the position assumed by the lower limbs from one of which the sympathetic had been removed; the normal hind leg being held in a flexed attitude, while the other took up a more abducted and extended position. Similar differences were noted in decerebrate animals, though to less degree.

The following results of sympathetic ramisection were noticed in human beings. In a spastic paraplegia on the side on which ramisection had been done passive dorsiflection of the ankle was immediately followed by relapse into an attitude of plantar flexion, while on the unoperated side the position of dorsiflexion was maintained, and the foot fell slowly back into plantarflexion.

In a second spastic paraplegia, the knee jerk could not be elicited and the limb would remain indefinitely in any position imposed upon it passively. The patient had practically no control of the movements of his legs before operation. After ramisection, lengthening-and-shortening reactions were not present and it became possible to elicit the knee jerk.

A third patient showed the "step-ladder" phenomenon on eliciting the knee jerk before operation; this became lost after ramisection. In a fourth patient with post-encephalitic rigidity, the toes were in constant strong dorsiflexion; immediately after ramisection this overaction in the dorsiflexion was lost. The influence of ramisection in establishing the ability to balance in spastic individuals is said to be quite spectacular. The author feels that we must conclude that the sympathetic nerves have a distinct and important influence on tone. Most normal individuals can inhibit the contraction of muscles; the spastic paralytic cannot, and this constitutes his initial disability; however the removal of the sympathetic nerve does not abolish the conscious patient's power of maintaining posture.—*Dr. Edward N. Reed, Santa Monica, Calif.*

VISEROPTOSIS IN RELATION TO POSTURE. J. Renfrew White. *Med. J. Australia*—Supplement No. 5, 133, Sept. 10, 1927.

The material for this paper is drawn from examination of several hundred individuals, from primary school age to the age of twenty-one. The author believes that much chronic disease and disability is due to mechanical misuse of the body. The present paper deals with the relation between faulty posture and viseroptosis, which the author considers essentially an orthopaedic problem. In its production there are usually two factors; (1) a congenital looseness of the attachment of the abdominal viscera; and (2) lifelong habits of faulty posture. These are particularly prone to occur in those of tall, slender build. The congenital factor alone is responsible in a very small number of cases.

In the erect position the body assumes either the active posture or the passive or relaxed posture; the former when effort is being made, the latter when resting or when tired. Radiograms made in the two postures show the great difference in position of the stomach and bowels which takes place in the transition from the active to the passive posture.

The tendency of civilization is to replace the active posture by more or less continuous passive or relaxed posture. The effect of this during the growing years is to produce an actual anatomical change in the relations of the viscera. In the author's examinations the following points have been noticed:

1. The inclination of the pelvis.
2. The extent of lumbar lordosis.
3. The extent of dorsal kyphosis.
4. The position of the head forward in relation to the trunk.
5. The relative prominence of upper and lower parts of the abdomen.
6. The position in which the chest is held, whether nearer that of full inspiration or of full expiration.
7. The general shape and diameters of the chest.
8. The size of subcostal angle.

The results were grouped under four grades:

A. Approximately perfect posture.

B. Perfect relation of pelvic and lumbar spine, but the head forward position and a flat chest, with prominent lower segment of the abdomen and a round back.

C. As in "B" but with increase in lumbar lordosis.

D. Posture faulty in all of its elements.

Among the primary school girls eleven per cent. had approximately perfect posture. Fifty-four per cent. had lesser degrees of postural fault, and thirty-five per cent. high degrees of postural defects. Among the high school girls, ten per cent. fell in the first

class, forty per cent. in the second, and fifty per cent. in the third class. In girls between eighteen and twenty-one years of age the first group were six per cent., the second thirty-nine per cent., and the third group fifty-eight per cent. It is concluded that the percentage of postural defects increases as the age advances.

Viseroptosis is regarded not primarily or chiefly as an abdominal condition, but rather as an abdominal result of a more wide-spread anatomical disorder. Its effect likewise is wide-spread through its production of intestinal stasis. Neither should its treatment be regarded as an abdominal problem. Surgery for its relief is considered a failure. Exercises for the abdominal muscles and the wearing of belts are aimed at the correction of its less important causes only. The broad basis of treatment must be an overhauling of the entire body mechanics, by such reeducation as will lead to the assumption of correct posture. This physical education should be far more a training of the sensory, than of the motor parts of postural reflexes; a training in kinaesthesia.

The patient must be taught to sense what correct posture is, the feeling of alignment; and then his musculature must be developed and toned up to enable him to maintain this posture.—*Edward N. Reed, M.D., Santa Monica, Calif.*

KÜMMEL'S DISEASE: POST-TRAUMATIC SPONDYLOPATHY. W. R. Stowe. *Med. J. Australia.* Supplement No. 5, 141, Sept. 10, 1927.

The literature on this subject is scanty. The most comprehensive article quoted was one by Dr. Fosdick Jones in 1923. Kümmel's original statement defined the condition as a post-traumatic spinal deformity, predisposed by trauma, and having first a stage of initial injury, a second stage of comparative well-being, and a third stage coming after weeks, months or even a year, of an angular kyphosis, with development of pain; local over the spine, or radiating down the extremities.

After 1921 eighty-four cases are reported in the literature. The causative trauma may be either direct, or the result of extreme bending or torsion of the spine. The author feels that all victims of spinal trauma should be kept under observation and examined at intervals by a radiologist until the development of a post-traumatic change in the vertebral bodies can be ruled out.

With an extreme compression or torsion on a vertebral body there must occur either impaction of the trabeculae, or disruption by a tearing action. With this there probably occur minute hemorrhages. The report of one autopsy made shortly after death in a severe spinal injury showed no compression fracture, but rupture of vessels in the spinal segments which would have caused impaired nutrition and probable necrosis of the spongy trabeculae of the body. Two cases are reported with the clinical findings and x-rays. There are no comments on treatment.—*Edward N. Reed, M.D., Santa Monica, Calif.*

STIFF AND PAINFUL SHOULDER. A REVIEW. Ramirez y Santos. *New Orleans Med. and Surg. J.*, Nov. 1927.

The anatomy of the shoulder joint is touched on and the causes of painful shoulder are classified as direct and indirect.

As this article is simply a review, the author's summary and conclusions are given in full:

1. Lesions of the subacromial bursa and the tendon of the supraspinatous muscle are the most common causes of stiff and painful shoulder.
2. The arthritides of the joints may also be considered as important factors.
3. Many cases which are diagnosed as contusions of the shoulder joint, neuritis, peri-arthritis and muscular rheumatism are in reality due to lesions of the subacromial bursa and the supraspinatous tendon.

4. The cause of pain in the shoulder region in cases of abdominal lesions is irritation of the diaphragm and not of the abdominal viscera.

5. Pain in the tip of the shoulder is likely to be of diagnostic value in subphrenic abscess, diaphragmatic pleurisy, actinomycosis of the chest, perforation of gastric and duodenal ulcers and probably ectopic pregnancy.—*Edward S. Hatch, M.D., New Orleans, La.*

A Case of Lumbar Rib. M. Bariety and E. Picart. Presented at the *Société anatomique de Paris*, Meeting of July 7, 1927.

Woman, twenty-six years old. Recent spontaneous pain increased by effort and localized on the left, at the level of the fifth lumbar vertebra. The radiogram showed an osseous mass, oblique from below to the outside, detached from the left transverse process, and directed toward the posterior border of the internal iliac fossa. The transverse process was resected. The anterior mass of bone was anterior to this and showed on its distal extremity of the articular surface.

There was disappearance of pain. It is evident that it was a question of a lumbar rib and not of an ossification of a ligament.—*Docteur M. Galland, Berck-Plage.*

An Operation for Extra-articular Fusion of the Sacro-iliac Joint. W. C. Campbell. *Surg. Gynec. Obstet.*, XLV, 218, Aug. 1927.

The object of the operation is to induce osseous union between the posterior surface of the sacrum and the overhanging portion of the ilium, thus causing an extra-articular ankylosis. An incision is made along the outer lip of the iliac crest over its posterior one-third or one-half. The periosteum is elevated from the posterior surface of the ilium in this region. Soft tissues are removed from the iliac crest and the posterior surface of the sacrum. A portion of the crest is removed with chisel and the inner surface of the crest is denuded, making a raw gutter formed by ilium and sacrum into which is placed the graft previously removed, together with other small grafts or shavings from the ilium. The patient is placed on a Bradford frame for six weeks.—*R. Wallace Billington, M.D., Nashville, Tenn.*

The Orthopaedic Aspect of Low Back Pain in Connection with Pelvic Disorders. P. H. Kreuscher. *Surg. Gynec. Obstet.*, XLV, 482, Oct. 1927.

The author believes: (1) that only in comparatively few instances can low lumbar or sacro-iliac pain be attributed to pelvic disorders, *per se;* (2) that the nerve supply of the uterus and adnexa has a much higher origin than we generally believe; (3) that upon careful examination a more rational cause can be found in most backache cases; (4) that the care of back pain cases in women as well as in men belongs to the realm of the orthopaedic surgeon. More common causes of low back pain are osteo-arthritis, tilting or torsion of the fifth lumbar vertebra on the sacrum, faulty posture, especially flat-feet, foci of infection, stooping and other strains of lumbosacral and sacro-iliac joints, tuberculosis, etc.—*R. Wallace Billington, M.D., Nashville, Tenn.*

Orthopaedic Reconstruction Work on Hand and Forearm. A. Steindler. *Surg. Gynec. Obstet.*, XLV, 476, Oct. 1927.

This article is a tabulation of results of 450 operations on 250 patients. Of those for restoration of form there are four groups of cases; (a) flexion contracture of the wrist, treated by arthrodesis, or tendon operations; (b) pronation and supination contractures, treated by muscle and tendon resections and transplantations; (c) contractures of fingers, treated by osteotomies and resections, tendoplasties and capsulotomies; (d) skin contractures treated by various flap methods.

Of those for restoration of function there are five groups: (a) drop wrist and drop

fingers, treated by arthrodesis and tendon transplantations; (b) loss of supination, treated by transposing of pronator teres and transplantation of flexor carpi radialis; (c) impaired finger flexion, by tendon sutures, tendon transplantations and plasties; (d) peripheral nerve surgery including neurolysis, nerve suture and Stoeffel's operation; (e) thenar disability treated by the author's flexor plasty and Mayer's thumb-check operation.

Emphasis is laid on aftertreatment. For further details this article should be read in full.—*R. Wallace Billington, M.D., Nashville, Tenn.*

Sacro-iliac Subluxation as a Cause of Backache. H. Hoyt Cox. *Surg. Gynec. Obstet.*, XLV, 637, Nov. 1927.

This paper consists largely of the teachings of ten to fifteen years ago when practically all low back pains were said to be due to subluxations of the sacro-iliac joints. Infections and other types of arthritis are considered of importance only as "predisposing to relaxation of the sacro-iliac joint", an odd theory it would seem, as arthritic joints elsewhere are certainly not "relaxed". Of sixty-five acute cases treated by manipulation, strapping and rest in bed for one week all were relieved, fifty of them permanently. Of twenty cases treated by manipulation and strapping without rest in bed "all were relieved at once", and of ten cases treated by manipulation alone "all were relieved at once". This is a remarkable report.—*R. Wallace Billington, M.D., Nashville, Tenn.*

Paralytic Knee Fusions. O. L. Miller. *South. Med. J.*, XX, 782, Oct. 1927.

This operation was only done on severely paralyzed limbs of patients who could not hope to walk without braces or crutches. Twenty-five cases were done, ages nine to sixteen years. The Hibbs knee fusion operation was done. The patients and their families were pleased with the results obtained. The patients were able to walk without braces or crutches.—*F. G. Hodgson, M.D., Atlanta, Ga.*

On the Frequency of Rachitic Changes of the Skeleton in School Age Based upon Examination of 30,000 School Children. Horuhe. *Zeitschr. orth. Chir.*, XLVIII, 3, 321, Sept. 2, 1927.

The investigation showed that within school age, that is, from the sixth to the fourteenth year, only twenty to thirty per cent. of all children were free from rachitic deformities, and that there was a slight difference in favor of the female sex. Evidently with the advent of puberty a stronger regression of the rachitic changes takes place.

1. Crus Varum. There is an average frequency of forty per cent. with slight preponderance of the male sex. A spontaneous regression of this deformity during school years occurs only to a very limited extent, more frequently in later years.

2. Genu Valgum. There is relative frequency of twenty-five to thirty per cent. with slight preponderance of the female sex.

3. Genu Varum. This also is a typical rachitic deformity. The average frequency of this deformity is from three to six per cent. without preponderance of any sex. Spontaneous retrogression of this deformity apparently does not take place within school age. The increase of the deformity appearing after puberty can be considered as late rickets, which is more evident in boys than in girls. In general the deformity is more frequently encountered in the lower grades than in the higher grades of school. This is also true of the varum deformity of the femur, and of the anteroposterior deformities which are usually encountered in severe rickets only.

Another deformity which was investigated was the genu recurvatum. This is seen only in mild forms, more frequently in the earlier than in the higher grades of school.

Most of the deformities signifying a more severe rachitic condition appeared in combination. Of 587 varus deformities of the femur not less than 479 or eighty-two per cent. were combined with other deformities, principally with crus varum.

Of rachitic thorax deformities there were noted: 1. the thoracic deformities of milder type at a frequency of two to three per cent.; 2. the pectus carinatum, which is seen in a frequency of three-tenths to four-tenths per cent., more frequently in males. Older children were as much represented in this deformity as younger. The funnel chest was seen in more than one per cent. of the cases, although, according to many observers, this is a deformity of congenital origin.

The most important fact which appeared from this investigation of an unprecedented large number of children, was the high percentage of rickets, early and late in the metropolitan population, and the frequency of combined rachitic deformities.—*A. Steindler, M.D., Iowa City, Iowa.*

EPILEPTIFORM CRAMPS AFTER BLOODLESS ORTHOPAEDIC OPERATIONS. O. Mayr. *Zeitschr. orth. Chir.*, XLVIII, 3, 392, Sept. 2, 1927.

The author reports on three cases of epileptiform convulsions observed in the clinic in the last three years, after gradual stretching of the nerves following abduction or extension dressings.

Utgenaunt and others distinguish two serious complications following forcible redressment, namely, fat embolism and the epileptiform convulsions. Fat embolism is rare, and the author believes that its occurrence is still further restricted by the application of a constrictor before the redressment. Chronic convulsions (which have been described by Aberle and others many years before) have a much better prognosis. In Lange's clinic twenty-six cases were observed during the last twelve years. All cases concerned children from two to thirteen years with the exception of one adult case. In all cases the contracture had been of long standing, leading to shrinkage of the soft parts, and muscular atrophy from non-use. The epileptiform convulsions occur from two to six days after the operation and are accompanied by unconsciousness, slight dyspnoea; pulse and respiration, however, remain good. The improvement occurs after several hours and after one to two days the patient is usually well. It is essential that the tension of the nerve be immediately relieved by removal of the plaster bandages. Hot stimulants and chloral hydrate enemas may be given. The three cases reported by the author are an interesting contribution to our knowledge of the epileptiform convulsions which follow peripheral nerve stretching, though they do not essentially differ from older reports.—*A. Steindler, M.D., Iowa City, Iowa.*

THE ARTHRITIS DEFORMANS OF THE BIG-TOE JOINT AS AN INDEPENDENT SYNDROME. H. Watermann. *Zeitsch. orth. Chir.*, XLVIII, 3, 346, Sept. 2, 1927.

According to the degree of arthritis the complaints differ. Most patients complain of pain at the dorsal surface of the big toe joint as the foot is leaving the ground. The examination of the patient shows the first metatarsal head considerably thickened. In children and growing people this enlargement is less conspicuous and often overlooked. The skin over the big toe joint is often reddened and tender to pressure. An attempt to stand upon the toes results in twisting the foot outward so that the weight rests upon the outer toes. In advanced cases dorsiflexion of the toes is completely abolished. According to the author's experience the trouble is usually bilateral, contrary to a statement of Hohmann, who finds it unilateral as often as bilateral.

The x-ray picture shows the following changes: The metatarsal head is always broadened and in the later course it may take on very irregular contours. The joint fissure is narrowed and very often the joint bodies overlap in the x-ray picture. In the course of time the lateral edge of the head shows arthritic spurs and prominences, especially well seen in the lateral picture.

Hohmann was the first to call attention to the fact that this arthritis occurs also in juvenile age, having observed cases of from sixteen to eighteen years old.

Watermann finds distinct arthritic changes in children as young as nine to twelve years.

Concerning the etiology of the condition a uniform cause of the trouble could not be established. There are, evidently, cases of primary arthritis deformans in the big toe joint without concomitant changes in the foot. Occupational strain alone can not be made responsible and the author is inclined to assume a constitutional diastasis of the individual to respond to the strain of the weight-bearing with arthritic changes.

Treatment. An operative treatment is advised by Watermann which resembles the operations of Ludloff and of Hohmann, of the wedge osteotomy. The wedge is taken out of the head and neck of the metatarsal with the base pointing dorsally. The whole toe is then forced upward.

Other foot deformities may accompany arthritis of the big toe joint. On the other hand, the latter may be acquired secondarily as the result of false static alignment. Constitutional conditions play an important part in the etiology of this disease.—*A. Steindler, M.D., Iowa City, Iowa.*

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